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THE GENITALIA AND TERMINAL STRUCTURES OF THE MALE OF THE ARCHAIC MECOPTERON, *NOTIOTHAUMA REEDI*, COMPARED WITH RELATED HOLOMETABOLA FROM THE STANDPOINT OF PHYLOGENY

By G. C. Crampton

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For the rare privilege of studying the hitherto undescribed male of the intensely interesting archaic Mecopteron *Notiothauma reedi*, McL. (which is in some respects a "living fossil"—the last remnant of a primitive relict fauna, representing as closely as any living form, the type ancestral to the rest of the Mecoptera) I am deeply indebted to Professor Dr. C. E. Porter, who has done so much to advance the study of Entomology in Chile, and to Dr. E. P. Reed, the distinguished Chilean surgeon, who has been more than generous in supplying me with a wealth of material for morphological study. To both of these gentlemen I would express my profound gratitude for their aid in enabling me to carry out this investigation.

The abdominal structures of the male of *Notiothauma* are the most remarkable and primitive to be found within the order Mecoptera, and could readily serve as the archetypes of these structures for the rest of the order. The primitive character of these structures is thus in harmony with the evidence of the archaic character of *Notiothauma* indicated by other features such as the wings, which have been discussed in Psyche, Vol. 37, p. 83, for 1930, where

the male here described was designated as the allotype of *Notiothauma reedi,* McL.

The greater portion of the abdomen of the male of *Notiothauma* is of a castaneous color, but segments eight and nine (see fig. 1), and the gonopods labelled *cx* and *st* in fig. 1, are somewhat fulvous hued. The abdomen is rather broad and is somewhat flattened, and does not taper as the abdomen does in the Panorpidæ (*sensu stricto*), being more like the abdomen in the closely related family Meropidæ in this respect, although the genitalia are much more primitive than those of *Merope* (which are elongated and rather highly specialized), and the genitalia of *Notiothauma* might readily serve as the archetype of the genitalia of the Panorpidæ. On the other hand, the abdominal structures of *Notiothauma* present some remarkable modifications, which, with the general archaic character of *Notiothauma,* make it the most interesting and striking representative of the Mecoptera. Starting with the structures of the third abdominal segment and taking up the structures of the following segments in turn, I shall briefly describe the striking features of the abdomen, and point out wherein the structures of *Notiothauma* may serve as the starting point for tracing the evolutionary developments occurring in the other Mecopterous families.

In the posterior region of the third abdominal tergite of the male of *Notiothauma* there occurs a median unpaired structure labelled *n* in figs. 1 and 5, which, for the sake of convenience, may be referred to as the notorganus or notal organ. A conical median tergal structure labelled *po* in figs. 1 and 5, borne on the following (i. e., the fourth) tergite, abuts against the notorgan *n,* on the third tergite. I have followed Felt, 1896 (Rept. N. Y. State Entomologist for 1894, p. 463) in regarding the notorgan *n* as an alluring organ which gives out an exudate licked up by the female prior to mating. The notorgan *n* (and the posterior structure *po*) is not developed in other primitive Mecoptera such as *Merope, Chorista* and *Panorpodes,* (and it is likewise absent in the Bittacidæ, Nannochoristidæ and Boreidæ), so that *Notiothauma* furnishes the only starting point for tracing the development of these structures in the Pan-

orpidæ, in which the structures in question may become hugely developed. In *Panorpa stigmalis* (fig. 27) the notorgan *n* has become elongated and extends posteriorly to the cone *po,* which is located further back in segment four, while in *Neopanorpa cornuta* (fig. 26) the orthogenetic tendency for the notorgan *n* to become further elongated becomes more pronounced, since in the latter insect (fig. 26) the notorgan *n* projects posteriorly over the fourth tergite and nearly reaches the middle of the fifth tergite. In such Panorpids as *P. takenouchii* (fig. 29) the orthogenetic tendency for the notorgan *n* to become more and more elongated, reaches its culmination. Since *Notiothauma* furnishes the only starting point, among the lower Mecoptera, for the development of such a notorgan (*n* of fig. 1 and 5) this very clearly indicates that *Notiothauma* is the most like the ancestor of the Panorpidæ.

On the fifth tergite of *Notiothauma* there occurs a remarkable median unpaired tergal process labelled *mo* in figs. 1 and 5. This process is apparently peculiar to *Notiothauma,* although a shorter process, resembling it in some respects, is borne on the sixth (instead of the fifth) tergite of *P. cornigera,* shown in fig. 32. This process of the sixth tergite of *P. cornigera,* abuts against the dorsal portion of the seventh abdominal segment, when the end of the abdomen is turned forward on top of the abdomen, while in *Notiothauma,* the tips of the genital styles *st* of figs. 1 and 5 apparently lie on each side of the median process *mo* when the tip of the abdomen is turned up over the top of the abdomen of the male insect.

The sixth abdominal tergite of *Notiothauma* bears a pair of lateral tergal processes labelled *bc* in fig. 1, which are somewhat suggestive of the paired lateral tergal processes borne on the sixth tergite of *Neopanorpa cornuta* shown in fig. 26. Dorso-mesad of the processes *bc* on the sixth tergite of *Notiothauma* shown in fig. 1, are two smaller processes (paired) which may have developed as enlarged "setigera" or seta-bearing protuberances of the segment. These setigera bear dinotrichia or powerful bristles like those shown on the seventh and eighth tergites in fig. 1,

but most of the setæ and bristles have been omitted in fig. 1, to avoid making the figure too complicated to show the more important structures readily.

The seventh tergite in *Notiothauma* bears a pair of remarkable tergal processes labelled *bc* in fig. 1, which appear to correspond in a general way to the structures called the "bicornua" in the male Plecopteron shown in fig. 17, plate 2, of vol. 13 of the Bulletin of the Brooklyn Ent. Society for 1918, and this term has therefore been applied to the structures labelled *bc* in fig. 1 of *Notiothauma*. The "bicornua" of the seventh tergite in *Notiothauma* (*bc* of fig. 1) apparently serve to support the genital structures when the tip of the abdomen is turned forward over the top of the abdomen in the male insect. Since there are no such structures on the seventh tergite of the other Mecoptera I have examined, it is possible that these remarkable processes are peculiar to *Notiothauma* among the Mecoptera.

The abdominal segments (with the exception of the first) as far back as the eighth segment, in *Notiothauma*, are "discleritous"—i. e., the tergal and sternal sclerites are distinct and separate (the tergites are denoted by the letter *t* and the sternites by the letter *s* in fig. 1)—and the spiracles labelled *sp*) are located in the pleural or lateral membrane between the tergites and sternites. The fulvous-colored eighth and ninth abdominal segments, however, are "synscleritous"—i. e., the tergites and sternites have united to form a complete ring or continuously sclerotized surface from dorsal to ventral sclerite, and the spiracle of the eighth segment (which is larger than the preceding ones) is surrounded by the sclerotized surface, instead of being located in a pleural membrane.

In *Panorpodes* the eighth and ninth segments are synscleritous (tergites and sternites fusing completely) and the seventh segment is partially synscleritous, the fusion of the tergite with the sternite being complete in the anterior half of the segment, but the posterior half retains a partial division between tergite and sternite. *Panorpodes* thus presents an intermediate stage between *Notiothauma* (in which only the eighth and ninth segments are synscleritous) and the Panorpidæ in which the seventh, and

sixth segments also, are synscleritous. *Panorpodes* likewise presents an intermediate condition between the posterior abdominal segments of Notiothauma, which are broad and flattened, and the narrow more cylindrical segments of the postabdomen (narrowed region) of the Panorpidæ, since the segments in *Panorpodes* are somewhat narrower than those of *Notiothauma* but are not as narrow as those of the Panorpidae, in the postabdomen. As was mentioned above the sixth, seventh, eighth and ninth segments are synscleritous in the Panorpidæ; the sixth is discleritous, the seventh partially so, the eighth is synscleritous and the ninth is synscleritous in Panorpodes; the sixth and seventh abdominal segments are discleritous and the eighth and ninth are synscleritous in *Nannochorista* and *Notiothauma*. In *Chorista* and *Merope* the sixth and seventh abdominal segments are discleritous and the eighth and ninth are weakly so. In *Boreus* and *Harpobittacus* the sixth, seventh, eighth and ninth (reduced in *Harpobittacus*) abdominal segments are discleritous.

The ninth segment of the male has been termed the andromere (since it is the genital segment "par excellence") and the ninth segment together with the genitalia constitute the androecium, or as the Dipterists term it, the hypopygium. The andromere or ninth segment presents some intensely interesting modifications in *Notiothauma*. Its tergal region or epiandrium labelled *ep* in fig. 1, bears a remarkable median dorsal process (labelled *g* in fig. 1 and fig. 4) which is turned slightly forward. The lateral portions of the epandrium on each side of the median process *g* are produced posteriorly to form two lobe-like projections labelled *e* in figs. 1, 4, 5 and 37, and these epandrial processes bear lesser lateral projections as is shown in figs. 1 and 4 of *Notiothauma*. These epandrial processes are apparently homologous with the processes and lobes of the ninth tergite variously termed the surgonopods, surstyli, epivalvæ, epiprocessi, etc., in different insects. The condition exhibited by *Notiothauma*, in which the epandrium is produced posteriorly to form the epandrial lobes *e* above the anus-bearing structures *pg* of fig. 37, apparently

represents the starting point of the development of the epandrial processes and lobes of other Mecoptera.

In *Merope* the epandrial processes *e* of fig. 36 are broad, flat, pointed plates clearly demarked from the tergite behind them. In the Bittacidæ represented by *Harpobittacus* (fig. 35) the epandrial lobes become highly developed, and in some Bittacidæ they are extremely large and are provided with roughened areas suggesting that they may play a part in mating (as claspers), and on this account they were referred to as the "copulalobi" in the Bittacidæ, but it is preferable to designate all of these lobes and processes of the ninth tergite as the epandrial processes (or lobes). In *Harpobittacus* the first abdominal segment (which is provided with a huge spiracle) is very small, so that the ninth segment might be counted as the eighth if the true first segment were overlooked, but by counting the eight pairs of abdominal spiracles one can determine the corresponding segments, even when the first segment has fused with the metathorax as in *Boreus,* and when there has been a fusion or suppression of segments, the spiracles furnish the clews for determining whether the fusion has been in the anterior or posterior region of the abdomen, since if there are eight distinct, spiracle-bearing segments in the abdomen when the number of segments has been reduced, it is evident that the fusion has occurred posterior to the eighth segment. In the Boreidæ, the epandrial lobes *e* of fig. 33 are rather densely beset with small protuberances giving a roughened appearance to their dorsal surfaces. The epandrial processes are not developed in *Chorista* (fig. 34) or *Panorpodes* (fig. 31) or most Panorpidæ (fig. 31), and the character of the epandrium *ep* of *Chorista* and *Panorpodes* (figs. 34 and 31) points to a rather close relationship between these insects, and *Panorpodes* is apparently closely related to the ancestral Panorpidæ among the Mecoptera. In *Chorista* and *Panorpodes* (figs. 34 and 31) the anus-bearing structure *pg* is not covered by the epandrium *ep,* but in the Panorpid shown in fig. 28, the epandrium *ep* is produced posteriorly and completely hides the proctiger beneath it.

The hypandrium or sternal portion of the ninth segment (andromere) is extremely interesting in *Notiothauma* (i. e., *ha* of figs. 7 and 21), and its condition in *Notiothauma* might be taken as the starting point for tracing the modifications of the hypandrium of other Mecoptera (see *ha* in the different figures), although the hypandrium *ha* of *Chorista* shown in fig. 18 might also be taken as the starting point in tracing the development of the hypandrium in other Mecoptera. The hypandrial processes labelled *h* in figs. 18, 21, etc., have been termed the hypovalvæ, hypoprocessi, etc., but in the following discussion they will be referred to simply as the hypandrial processes. In *Notiothauma* (figs. 1, 7 and 21) the hypandrium *ha* (which is divided into a basal and distal area) bears an unpaired median process and two lateral processes, while in *Chorista* (fig. 18) the median process is not developed, and there are small secondary mesal processes on the lateral hypandrial processes labelled *h* in fig. 18. In *Merope* (fig. 19) and *Boreus* (fig. 17) the hypandrial projections *h* are very slightly developed. In *Panorpodes* (fig. 20), however, the hypandrial processes *h* are well developed (and are provided with peculiar outgrowths, as shown in fig. 20), and in the development of its hypandrial processes, *Panorpodes* approaches the Panorpidæ more closely than any other lower Mecoptera do. In most Panorpidæ, such as the one shown in fig. 22, the hypandrial processes are well developed and in the Indian Panorpid shown in fig. 23, which has the most peculiar hypandrium of any Mecopteron I have seen, the hypandrial processes *h* curve about a somewhat circular basal opening, and are produced posteriorly into elongated processes which are modified apically to form the peculiar distal structures shown in fig. 23. The hypandrium is not prolonged posteriorly in the Bittacidae or Nannochoristidæ.

The male genitalia proper consist of the gonopods *cx* and *st* of fig. 13 and the structures comprising what the Dipterists call the phallosome, made up of the valvæ and other projections about the penis or the genital opening—i. e., the central structures labelled *ps* in fig. 13. It is very difficult to interpret the homologies of the male genitalia in the

different orders of insects, and the homologies of the parts in Diptera, Mecoptera, etc., are still in dispute.

In a discussion of the male genitalia of Diptera, Mecoptera, and related forms, published in Vol. 25, p. 47, of Psyche for 1918, the structures labelled *st* and *cx* in figs. 3, 7, 8, etc., were designated as the gonopods; but in attempting to homologize the gonopods of sawflies (which are fundamentally like those of Diptera and Mecoptera, but are of a more primitive type) with the gonopods of male Ephemerids, etc., which have retained the parts in practically the original condition for insects in general (see Canadian Entomologist, Vol. 52, p. 178, for 1920), I was misled by the fact that the bilobed basal plate (called the "cardo" by Hymenopterists) of some sawflies' genitalia resembles the fused coxites in the male genitalia of certain mayflies and the two-segmented forceps of these sawflies resemble the styli of certain mayflies, in which the styli are composed of two or more segments. Using the condition exhibited by these sawflies as the basis for determining the homologies of the parts in Diptera and Mecoptera, I consequently homologized the segment labelled *st* in figs. 3 and 7, of the Diptera and Mecoptera with the distal segment of the stylus (i. e., with the dististyle) and homologized the basal segment labelled *cx* with the basal segment of the stylus (i. e., with the basistyle), and interpreted the demarked basal areas of these basistyles as the reduced coxites in Diptera and Mecoptera (see also Vol. 48, p. 207, of the Transactions of the American Ent. Soc. for 1923). In his review of Dr. Alexander's "Craneflies of New York," however, Walker, 1920 (Canadian Entomologist, Vol. 52, p. 190), states that in the Diptera the distal portion of the claspers (i. e., *st* of fig. 3, represents the entire stylus, while the basal portion *cx* of fig. 3 represents the coxite instead of the basal segment of the stylus, and Eyer, 1924, (Annals Ent. Soc. of America, Vol. 17, p. 275) applies this interpretation to the Mecoptera and other Holometabola. Mr. R. E. Snodgrass, who has been making a detailed study of the musculature of the genital claspers, etc., of male insects, informs me that the musculature bears out the view that the basal segment of the gonopods (labelled *cx* in the

different figures) is the coxite, and the distal portion (*st* in the different figures) represents the entire stylus, so that I have provisionally adopted this view of the interpretation of the parts of the gonopods in the present paper. Mr. Snodgrass is inclined to regard the basal collar called the "cardo" in the genitalia of Hymenoptera, as a detached basal portion of the coxites, which has united with its fellow from the opposite side to form a basal collar-like sclerite in these insects, while the basal segment of the (outer) claspers represents the remainder of the coxite, and the outer claspers themselves represent the styli, in the Hymenoptera, and this view seems to be as reasonable as any, since it is in accord with the evidence of the musculature of the structures in question. It should not be forgotten, however, that Emery, Wheeler, and other students of the ants, interpret the basal and distal portions of the outer claspers (i. e., the gonopods) as parameres, and the question of the homologies of the parts of the gonopods is by no means settled as yet. In the following discussion, I shall refer to the claspers *st* of figs. 3, 7, 8, etc., as the gonostyles, and shall designate the basal portions *cx* as the gonocoxites, terming them both together, the gonopods.

The gonopods *st* and *cx* of *Notiothauma* (figs. 1, 5 and 7) not only furnish the prototypes from which the gonopods of the Panorpidæ and other Mecoptera could be derived, but they are also surprisingly like the gonopods of primitive Diptera such as *Trichocera* (fig. 3), suggesting that the ancestors of the Diptera were very like *Notiothauma* in the character of their genitalia. Thus, the gonostyle *st* of *Trichocera bituberculata* Alex., shown in fig. 3, has a mediotubercle *m* and a basitubercle *b* astonishingly like the meditubercle *m* and the bastitubercle *b* of the gonostyle of *Notiothauma* shown in fig. 7, but I have not found any Dipteron in which the gonostyle (*st* of fig. 3) bears a peculiar stylorganus (or stylar organ) like that labelled *o* in the gonostyle *st* of *Notiothauma* shown in fig. 7, although such a stylar organ is not found in all of the Mecoptera either, being apparently absent in *Chorista and Panorpodes* (figs. 12 and 13) and in all of the Panorpidæ and Bittacidæ that I have examined. A stylorgan *o* is present in *Notiothauma*

(figs. 1, 5 and 7), in *Merope* (fig. 13), in *Nannochorista* (fig. 10) and in *Boreus* (fig. 9), however, and this may indicate that *Notiothauma* is very like the common ancestors of all of these Mecoptera, since the ancestors of these forms must have had a stylorgan, if this structure is developed in these families.

Aside from the presence of stylorgans *o* in both *Notiothauma* (fig. 7) and *Merope* (fig. 16) the gonostyles *st* themselves are not very similar in the Notiothaumidæ and Meropidæ, since the gonostyli of Merope (fig. 16) are long and slender and resemble those of certain Chironomid Diptera in contour, while the gonostyli of Notiothauma are more like those of the Dipteron *Trichocera bituberculata* in contour, and it is amazing that the gonostyli of these closely related famiiles of Mecoptera (the Notiothaumidæ and Meropidæ, should resemble the gonostyli of Diptera more than they resemble each other.

The gonostyli *st* of *Notiothauma* (figs. 5 and 7) are more normal, and therefore furnish better starting points for tracing the development of the gonostyles of other Mecoptera than is the case in other primitive Mecoptera such as *Chorista* (fig. 12) in which the basitubercle *b* and the meditubercle *m* are modified in a peculiar manner, and the gonostyle is not as much like those of *Panorpodes* (fig. 13) and the Panorpidæ (fig. 23) as the gonostyle of *Notiothauma* is.

The gonostyle *st* of the Indian Panorpid from Mysore, shown in fig. 23, is so astonishingly hairy that this remarkable Panorpid should be called "Panorpa hirsuta" if it should prove to be new to science, and an appropriate name is desired for it! The Panorpid shown in fig. 8 has remarkably "thin," leaf-like gonostyli *st* with a peculiar basitubercle *b* and meditubercle *m*, and with a very peculiar mesal process *en* or "endostyle" which may represent the inner branch of the divided gonostyli in Diptera (i. e., the so-called inner basistyle in certain Diptera). In comparison with the size of the coxites which bear them, the gonostyli *st* are rather short in the Boreidæ (fig. 9) and Nannochoristidæ (fig. 10); and in the Bittacidæ represented by *Harpobittacus* (fig. 11) the gonostyli *st* become tremen-

dously reduced—a feature which serves to set apart the Bittacidæ from the rest of the Mecoptera very sharply.

In *Notiothauma,* the gonocoxites *cx* of figs. 5 and 7, are more like the prototypes of the gonocoxites of the Panorpidæ (figs. 8, 23, etc.) than is the case in Chorista (fig. 12), although *Chorista* and *Panorpodes* are not sharply set off from the Panorpidæ in this respect. In *Notiothauma* (fig. 5) there is an intercrater *cc* or intercoxal region which is hollowed out and sclerotized in a fashion suggesting the prototype of the condition met with in primitive Diptera, and all of the features of the genitalia of Notiothauma suggest that the ancestors of the Diptera resembled *Notiothauma* in many respects.

In *Boreus* (fig. 9) the gonocoxites *cx* are quite large in proportion to the size of the gonostyles *st,* and there is a wide posterior, or ventral, intercoxal area *ic* of membrane between the gonocoxites *cx.* In *Nannochorista* (fig. 10) the gonocoxites *cx* are likewise very large in proportion to the length of the gonostyli *st,* but the intercoxal area has become sclerotized and the gonocoxites appear to be quite solidly united. In the Bittacidæ (fig. 11) the intercoxal area has likewise become sclerotized, but a partial suture remains to demark the distal region of the gonocoxites, which are hugely developed in proportion to the size of the gonostyli *st.*

In the Panorpid shown in fig. 8, the posterior intercoxal area contains a pair of membranous lobe-like valves, the postvalvæ labelled *p* in fig. 8. These are apparently homologous with the posterior valve-like structures labelled *p* in fig. 12 of Chorista and a similar pair of valves labelled *p* in fig. 15 of *Notiothauma.* The function and significance of these postvalvæ is not clear.

In the Panorpid shown in fig. 8, the intercoxal area contains a pair of ventral phallic valves labelled *v,* which are received in a flanged groove of the gonocoxite *cx,* and the Panorpid shown in fig. 8 likewise has a pair of dorsal phallic valves labelled *d,* which lie on each side of the meatus or gonopore, as the genital opening of the male is called. These valves may represent the penis valves of sawflies which form the ædeagus or chitinous parts about the penis in

higher insects. The penis valves have been homologized with the endopodites of the genital limbs of the ninth segment, while the gonostyli have been homologized with the exopodites of the genital limbs (gonopods) whose protopodites are represented by the gonocoxites, but the homologies of the genital valves of the male insect have not been definitely determined, and it is preferable to refer to them as parts of the phallosome, as is done by the Dipterists. The ornate valves labelled *d* in fig. 15 of *Notiothauma*, lie on each side of the gonopore and apparently represent the dorsal valves *d* of the Panorpid shown in fig. 8, while the ventral valves *v* of fig. 15 of *Notiothauma* may represent the ventral valves *v* of the Panorpid shown in fig. 8, although the ventral valves *v* of *Notiothauma* are poorly developed, and were difficult to make out in the dried specimen available to me for study.

In such Panorpids as *Panorpa lugubris*, shown in fig. 25, the dorsal valve *d* of each side is not divided, but the ventral valve of each side is divided into an upper ventral valve labelled *u* and a lower ventral valve labelled *l* in fig. 25. The ventral valves of *Notiothauma* are not thus divided into an upper and lower branch, but in *Chorista* (fig. 12) one of the branches of the lower valves forms one of the penisfilum valves labelled *pv* in fig. 12, and this pair of valves becomes greatly elongated to form the so-called penisfilum *pf* of the Bittacidæ (fig. 11), so that in this, and certain other respects, *Chorista* is more like the ancestor of the Bittacidæ, while *Notiothauma* is more like the ancestor of the Panorpodidæ and Panorpidæ. The phallosome *ps* of *Nannochorista* shown in fig. 10 is much reduced and in *Boreus* (fig. 9) the parts are usually retracted, although in the specimens shown in figs. 31 and 34 of plate 10, in Vol. 48 of the Transactions of the Amer. Ent. Soc. for 1923, a large eversible membranous penis was visible, being apparently extruded at the time of mating. The parts are as much alike in the Boreidæ and Nannochoristidæ as any, but the resemblance is not very marked in these two families, and it is difficult to determine where they branched off in the phylogenetic tree of the Mecopteran families.

Following the usage proposed in Vol. 13, p. 60, of the Bulletin of the Brooklyn Ent. Society for 1918, the terminal abdominal segments may be referred to as the terminalia, and the anus-bearing portion may be termed the proctiger, while the set-off papilla with the anal opening at its tip, may be called the anal papilla. In *Notiothauma* (figs. 1, 2 and 5) the anal papilla *ap* is surmounted by a process labelled *sr*, and below it is a lower process labelled *sb*. The condition exhibited by *Notiothauma* (fig. 2) suggests the beginning of the development of the parts of the proctiger and its processes exhibited by the Bittacid shown in fig. 24. in which the dorsal process labelled *sr* may have developed from one like that labelled *sr* in fig. 2, while the ventral process labelled *sb* in fig. 24 may have developed from a ventral process like that labelled *sb* in fig. 2. Although the cerci *ce* and proctiger of the Bittacasid shown in fig. 24 are hugely developed, these features are more normal in such primitive Bittacids as *Harpobittacus* (fig. 35), in which the tenth tergite appears to be well developed and sclerotized, and in such a highly specialized Mecopteron as *Nannochorista*, the tenth segment (or the tenth and eleventh together) is remarkably well developed and sclerotized. The cerci are apparently lost in *Boreus*, and the peculiar character of the proctiger *pg* of fig. 33 bears out the view that the Boreidæ are rather isolated Mecoptera. The proctiger *pg* of Merope (fig. 36) is long and slender, and is not as much like that of *Notiothauma* (figs. 1, 2 and 5), as would be expected from the fact that the Meropidæ and Notiothaumidæ are very closely related, and the character of these parts is therefore of no great significance in attempting to determine the closest affinities of the Mecopterous families. The proctiger *pg*, short cerci *ce* and other features are quite similar in *Chorista* (fig. 34) and *Panorpodes* (fig. 31), and this may possibly indicate that *Panorpodes* is related to *Chorista* as well as to *Notiothauma* among the primitive representatives of the Mecoptera. In the Panorpid shown in fig. 28, the epiandrium *ep*, or ninth tergite, is produced posteriorly and hides the proctiger, etc., which lies rather far back beneath the epiandrium.

In general, the abdominal structures of *Notiothauma* would indicate that this remarkable insect is a remnant of the ancestral Mecoptera, and is the nearest living representative of the ancestors of the Panorpidæ. The Panorpodidæ, however, are somewhat nearer the immediate ancestors of the Panorpidæ, occupying a position intermediate between the Notiothaumidæ and Panorpidæ, and they are also related to the Choristidæ. The Choristidæ occupy a position at the base of the lines of descent leading to the Bittacidæ. Certain features suggest a relationship between the Boreidæ and Nannochoristidæ, but these insects are too highly modified to determine their closest relatives among the other Mecopterous families, although the Panorpidæ may represent the types from which the Boreidæ were descended, judging from characters other than the male genitalia, and the Nannochoristidæ exhibit some affinities with the Panorpodidæ.

ABBREVIATIONS

a Apical portion of genital style (stylapex).

ap Anal papilla (anopapilla).

b Basal tubercle of genital style (basotuberculus).

bc Paired tergal processes (bicornua).

bs Basal portion of phallus (basiphallus).

c Dorsal and ventral stylocondyles, or pivotal processes of genital styles.

cc Coxal hollow (coxocrater).

ce Cerci.

cx Genital coxites (gonocoxites or gonocoxæ).

d Dorsal phallic valves.

e Epiandrial processes or lobes (surgonopods, surstyli, epiprocessi, etc.)

en Endostyle.

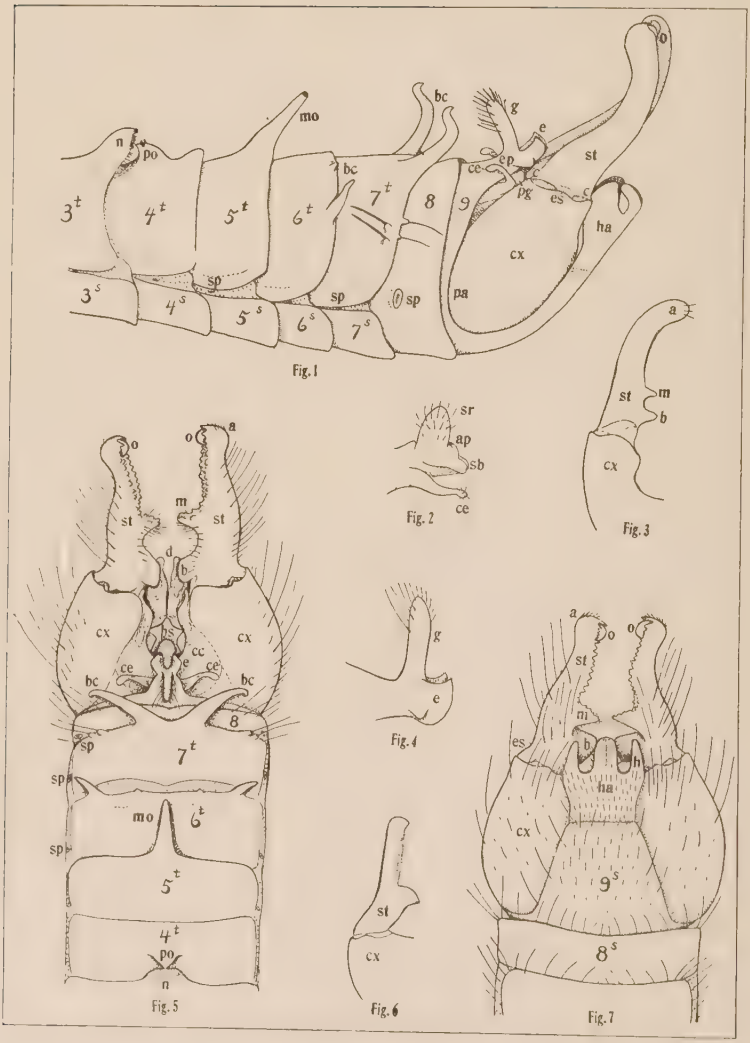
ep Epiandrium or ninth tergite.

es Epistyle, or process of genital style to which the extensor muscles are attached.

g Dorsal epiandrial process.

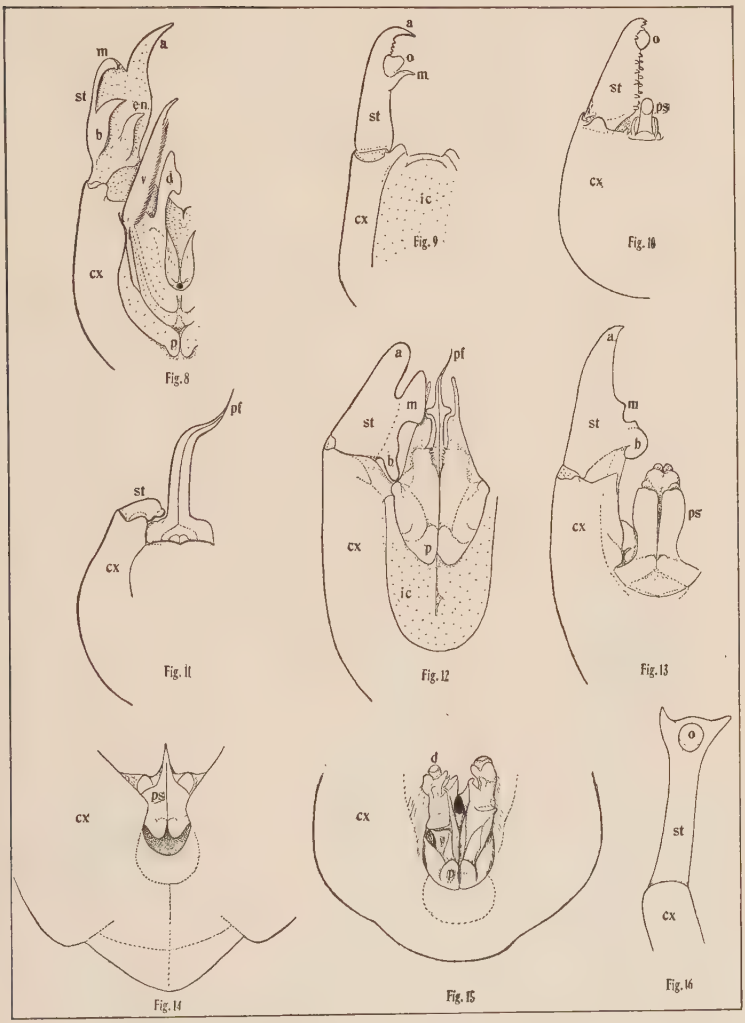
h Hypandrial processes (Hypoprocessi, hypovalvæ, etc.).
ha Hypandrium or tenth sternite.
ic Intercoxal area.
l Lower ventral phallic valves.
m Median stylar tubercle (medituberculus).
mo Unpaired median tergal process (monocornus).
n Notoörganus or notal alluring organ of male.
o Styloörganus or organ on genital style.
p Posterior phallic valves and lobes.
pa Parandrium.
pf Penisfilum valves, forming penisfilum in Bittacidæ.
pg Proctiger (anus-bearing region).
po Conical posterior tergal process (postorganus).
ps Phallosome or parts about genital opening.
sb Subpapilla.
sp Spiracles.
st Genital styles (gonostyli).
sr Surpapilla or suprapapilla.
u Upper ventral phallic valves.
v Ventral phallic valves.

Psyche, 1931. Vol. 38, Plate 1.



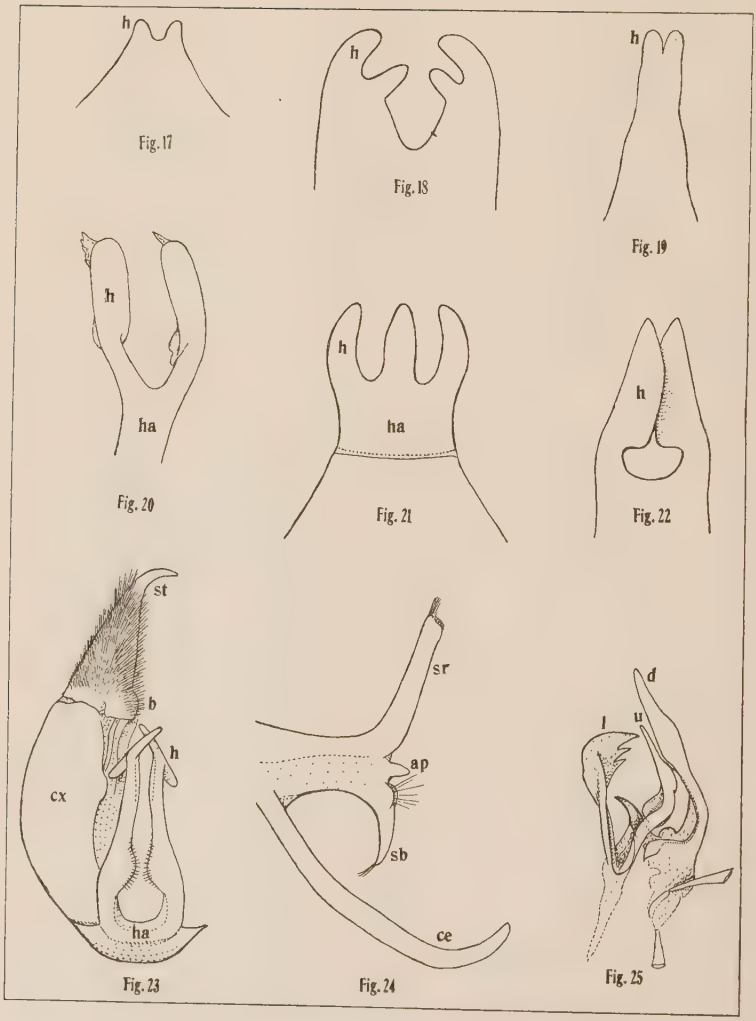
Crampton—Notiothauma.

Psyche, 1931. Vol. 38, Plate 2.



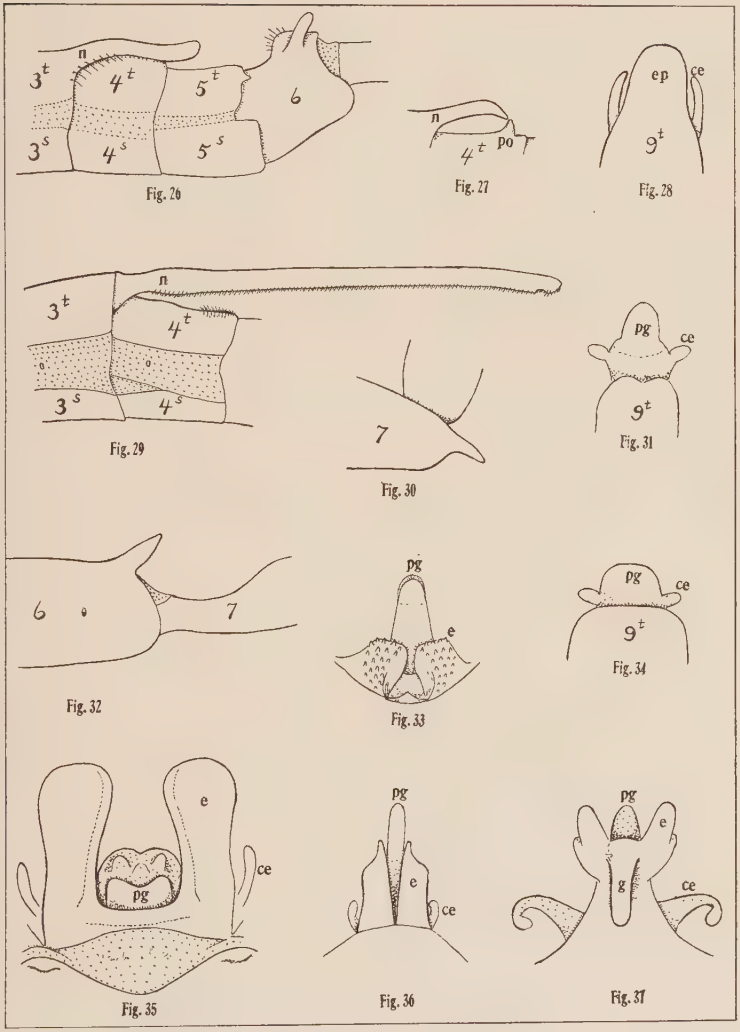
Crampton—Notiothauma.

Psyche, 1931. Vol. 38, Plate 3.



Crampton—Notiothauma.

Psyche, 1931. Vol. 38, Plate 4.



Crampton—Notiothauma.

EXPLANATION OF PLATES I—IV

Fig. 1. Lateral view of abdomen of male *Notiothauma reedi,* McL.

Fig. 2. Lateral view of terminal structures (terminalia) of *Notiothauma.*

Fig. 3. Ventral view of genital style and coxite of the Dipteron *Trichocera bituberculata,* Alex.

Fig. 4. Lateral view of epiandrium of male *Notiothauma.*

Fig. 5. Dorsal view of abdomen of male *Notiothauma.*

Fig. 6. Dorsal view of genital style and coxite of Dipteron *Trichocera garretti* Alex.

Fig. 7. Ventral view of terminal structures and genitalia of male *Notiothauma.*

Fig. 8. Ventral view of sinistral genital style, coxite and phallosome of a Panorpid.

Fig. 9. Same of *Boreus* sp.

Fig. 10. Same of *Nannochorista dipteroides,* Till.

Fig. 11. Same of *Harpobittacus* sp.

Fig. 12. Same of *Chorista australis,* Tillyard.

Fig. 13. Same of *Panorpodes* sp. from Japan.

Fig. 14. Ventral view of phallosome and basal coxites of *Merope.*

Fig. 15. Same of *Notiothauma.*

Fig. 16. Mesal view of genital style of *Merope.*

Fig. 17. Ventral view of end of hypandrium of *Boreus.*

Fig. 18. Same of *Chorista.*

Fig. 19. Same of *Merope.*

Fig. 20. Same of *Panorpodes* (from Japan).

Fig. 21. Same of *Notiothauma.*

Fig. 22. Same of *Neopanorpa opthalmica* (redrawn from Miyaké).

Fig. 23. Ventral view of sinistral half of genitalia of *Panorpa* sp. from India.

Fig. 24. Lateral view of proctiger of *Bittacus strigosus.*

Fig. 25. Lateral view of phallic valves of *Panorpa lugubris.*

Fig. 26. Lateral view of segments three to six of *Neopanorpa cornuta,* after Miyaké.

Fig. 27. Lateral view of notal organ and conical process of *P. stigmalis,* after Miyaké.

Fig. 28. Dorsal view of epandrium of *P. lugubris.*

Fig. 29. Lateral view of third and fourth abdominal segments of a Panorpid related to *P. takenouchii.*

Fig. 30. Lateral view of terminal region of seventh segment of *P. bicornuta,* after Miyaké.

Fig. 31. Dorsal view of epandrium and proctiger of Japanese *Panorpodes.*

Fig. 32. Lateral view of terminal region of sixth segment of a Panorpodid related to *P. cornigera.*

Fig. 33. Dorsal view of epandrium and proctiger of *Boreus.*

Fig. 34. Dorsal view of epandrium and proctiger of *Chorista.*

Fig. 35. Same of *Harpobittacus.*

Fig. 36. Same of *Merope.*

Fig. 37. Same of *Notiothauma.*

TWO NEW SPECIES OF FUNGUS GNATS OF THE GENUS APEMON

By Charles W. Johnson

Boston Society of Natural History

Early in June, 1930, in company with Mr. Stuart K. Harris, a trip was made to Storrs, Connecticut. While collecting along the Willimantic River, a handsome specimen of a fungus gnat, representing a new species of Apemon, was taken. For some time I have not been satisfied with the determination of the eastern specimens referred to *Apemon maudæ* Coq., although one female from Franconia, N. H., was determined by the author of the species. I therefore take this opportunity to correct this error.

Apemon similis sp. nov.

A. maudæ Johnson (not Coquillett) Fauna of New England, List of Diptera, p. 77, 1925.

Head and antennæ black, with the under side of the first and second antennal joints yellow, palpi yellow with a black spot on the upper side of the second joint. Thorax shiny black, with subdorsal and lateral rows of fine yellow hairs, a triangle back of the humerus and dorso-pleural suture yellowish, scutellum and pleura black. First and second abdominal segments entirely black, the others reddish, the third and last segments having a blackish posterior margin. In the males only the fourth segment is reddish in one, and in another (Holotype) the base of the third and fifth segments are also reddish. Femora bright yellow with only a small black spot at the base of the posterior coxæ

and also on the under side of the tips of all the trochanters, tibiæ and tarsi brown, tibial spurs and halteres yellow. Wings yellowish gray, a brown spot extending from R1, before its apex to the posterior branch of the media near its base, apex of the wing from near the tip of R4+5 to the anal cell grayish brown; other characters are shown in fig. 1.

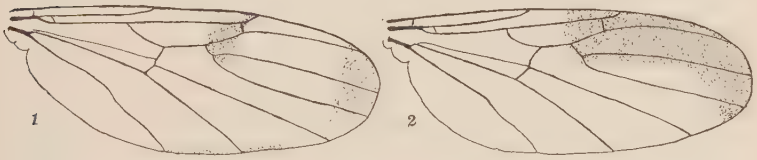


Fig. 1. Wing of *Apemon similis* sp. nov.
Fig. 2. Wing of *Apemon manteri* sp. nov.

Length of male 9.5 mm; female 9 mm.

Represented by two males and two females. Holotype, Bretton Woods, N. H., June 28, 1913 (C. W. Johnson). Allotype Franconia, N. H. (Mrs. Slosson). Paratype Tuckerman Ravine, Mt. Washington, N. H., July 8, 1914 (C. W. J.) in the collection of the Boston Society of Natural History. Paratype Oquossoc, Rangeley Lake, Maine (C. W. J.) in the Museum of Comparative Zoology.

Apemon manteri sp. nov.

Head black, palpi yellow, antennæ black with a dull yellow spot on the under side of the first and second joints. Thorax black, subshining with subdorsal and lateral rows of fine yellow hairs more conspicuous above the base of the wings, a triangle back of the humerus and the dorsopleural suture yellowish, pleura above the front coxæ with yellow hairs, the rest of the pleura and metanotum naked

and subshining, scutellum black with fine yellow hairs. Abdomen black, hairs on the first and second segments entirely black, the second segment about double the length of the first, the other segments with indistinct bands of yellow hairs at the base of each segment, the anterior angles of the fourth segment and the ventral surface of the fourth and fifth segments brownish. Genitalia black. Coxæ and femora bright yellow, a small black spot at the base of the middle and posterior coxæ and on the under side of the tips of all the trochanters, tibiæ and tarsi dark brownish, becoming black on the outer half of the tarsi, tibial spurs yellow, halters yellow. Wings with the basal two-thirds hyaline, yellowish at the base, the rest of the wing deep black, which extends along the anterior from forks of the radius to beyond the end of R5 as shown in fig. 2. Length 9 mm.

One male collected on the west side of the Willimantic River near Mansfield Station, Conn., June 6, 1930. Type in the collection of the Boston Society of Natural History. This species was taken while collecting with Prof. Jerauld A. Manter of the Connecticut Agricultural College, Storrs, Conn., to whom I have dedicated this interesting species.

A NEW NAME FOR *NEBRIA VANDYKEI* DARLINGTON

By P. J. Darlington, Jr.

It is my painful duty to announce that the name *Nebria vandykei*, used by me in Psyche 37, 1930, p. 104, for a species from Paradise Valley, Mt. Rainier, is preoccupied. The preoccupying name is *Nebria vandykei* Bänninger (Koleopterologische Rundschau 14, 1928, p. 5), which has been applied to a species quite different from mine, although from the same locality. I therefore propose the name *Nebria paradisi*, nom. nov., for the species described as *N. vandykei* Darlington. I am indebted to Dr. M. Bänninger and Dr. M. H. Hatch for calling my attention to Dr. Bänninger's paper.

AN INTERESTING COPY OF WIEDEMANN'S DIPTERA EXOTICA

About 1893 I purchased a copy of Wiedemann's "Diptera Exotica" from a European dealer. I did not examine it carefully at the time, and it was not until about 1915 that I discovered that pages 39 to 42 were missing. Comparing it with the copy in the Boston Society of Natural History, I find that the title page is quite different and reads as follows:

DIPTERA EXOTICA

Sectio I. antennis multiarticulatis

Munus Decani Fac. Med. deponens
edidit

Dr. C. R. G. Wiedemann

Kiliæ 1820

Following page 38 instead of page 39 is the usual title-page of the work:

C. R. G. WIEDEMANN

Med. Doctoris, in Acad. Kiliensi Prof. Med. P. O.

DIPTERA EXOTICA

Pars I

TABULIS ÆNEIS DUABUS

Kiliæ 1821

Following this and in place of page 41 is the sub-title page

Dipterorum exoticorum

Sectio II

Antennis parumarticulatis

which is placed in front of page 43, "Supplementum ad sectionem I." It should have been placed in front of page 45, "Section II. Antennis parumarticulatis."

The text on page 38 ends some distance from the bottom, with a ———. Evidently whoever compiled the book lacked pages 39-42, and, thinking that the two leaves containing the title page of 1821 and the sub-title of Sectio II, filled the gap, bound them accordingly. All references to this work bear the date 1821. However, from the copy here described, it is very evident that the first 38 pages and probably pages 39-42, and the supplement to Section I, pages 43 and 44, were published in 1820 and not in 1821. Pars I on the title page of 1821 would indicate that the author contemplated other volumes.

It would be of interest to know if there are any other copies giving 1820 as the date of publication of the first section. This copy has been presented to the library of the Boston Society of Natural History.

Charles W. Johnson.

SOME PRELIMINARY NOTES ON THE GENUS EPHEMERELLA

By Anne Louise Steger

Cornell University, Ithaca, N. Y.

In an attempt to fill in some of the gaps left by Miss Anna H. Morgan in her study of the Mayflies of Fall Creek in 1911 (Ann. Ent. Soc. Am. 4:93-119), some rearing and collecting work was carried on during the summer of 1930 at Cornell University under the direction of Dr. Needham with the genus Ephemerella. As a result I was able to obtain stages of several of the local species which had not as yet been taken or described. Following is a table of the local species taken, indicating those stages which had already been described (*D*) and those which had not, and which were collected last summer (*U*):

Species	*Nymph*	*Subimago*		*Imago*	
		♂	♀	♂	♀
E. cornuta	D	D	U	U	U
E. deficiens	D	D	D	D	D
E. dorothea	D	U	U	D	D
E. rotunda	D	U	D	U	D
E. septentrionalis	U	U	U	D	U

The rearing of the nymphs to the subimago and imago stages was carried on in a deserted pump house on Beebe Lake, where it was possible to have a constant supply of fresh water running through the troughs. The nymphs were collected in streams by means of a small wire hand screen, brought home and put into wire cages in the troughs, after having been properly identified and separated according to species. The cages were labelled with

name of species and collecting data, and were visited once or twice a day in order to catch the subimagos as they crawled out of the water onto the part of the cage above water. The subimagos were then put into paper bags, which were labelled as to species, date of collecting and date of subimago transformation. The paper bag, because of the roughness of its surface, offers an excellent place for the imago to crawl out of its subimago skin. The paper bags were investigated each day, also, in order to get the imago as soon after transformation as possible. As a result, all stages of the above-listed species were obtained, and some observations made on the relative length of time of subimaginal transformations. For the most part, the males in all species reared seemed to require slightly more time than the females for this last molt.

The collecting was done in the streams around the general vicinity of Ithaca. Fall Creek borders the campus on the north and collections were made in it at various points from the campus to Freeville, a small town about eight miles northeast of Ithaca. Cascadilla Creek borders the campus on the south, collecting being done in it upstream over a distance of about three miles. Further collecting was done in Salmon Creek ten miles northeast of Ithaca, in Van Buskirk's Glen ten miles to the south, in Slaterville Wild Flower Preserve fifteen miles to the east, in Six Mile Creek two miles to the south, in North Harford Brook (Cortland County) twenty to twenty-five miles to the northeast, in North Spencer Stream about fifteen miles south, in Enfield Glen seven miles to the south, and in Otter Creek which borders on the southwest of Cortland, N. Y.

Ephemerella cornuta Morgan

Male imago:

Measurements: body 10 mm., tails 11 mm., fore leg 9.5 mm., fore wing 9 mm., hind wing 2.5 mm. Eyes and ocelli dark brown; antennæ light-brown. Thorax a uniform dark brown. Abdomen a rather light gray-brown. Wings hyaline, brownish at the bases. Axillary cords of the fore

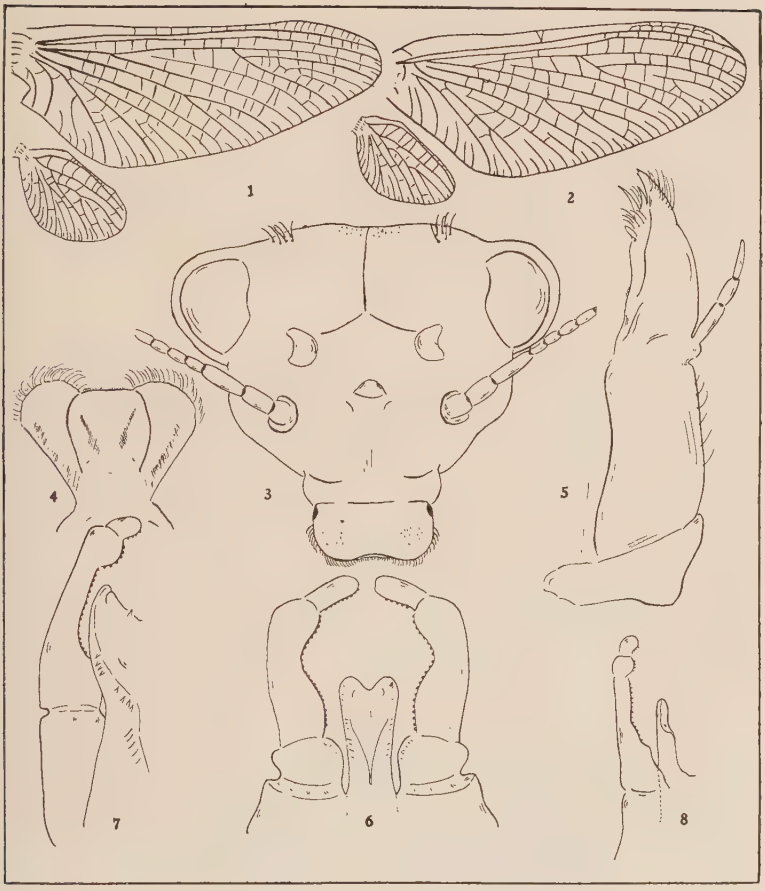


Fig. 1.

1. *E. septentrionalis*—wings of adult;
2. *E. cornuta*—wings of adult;
3. *E. septentrionalis*—head of nymph;
4. *E. septentrionalis*—hypopharynx;
5. *E. septentrionalis*—maxilla;
6. *E. cornuta*—forceps and penes of adult;
7. *E. rotunda*—forcep and penis of adult;
8. *E. septentrionalis*—forcep and penis of adult.

wing extending backward on each side of the median lobe of the metathorax, in slender points. Tails three, whitish. Last segment of the forceps rather elongate, not bulbous; second segment with a rather bulbous swelling at each end.

Female imago:

Measurements: body 9 mm., forewing 10 mm., hindwing 3 mm. Color of thorax a dark brown similar to that of the male. Abdomen a slaty-gray, due probably to the egg mass which showed through.

Subimago:

Wings smoky in color. This nymph was taken as early as May 16th in North Harford Brook. It was found in greatest abundance and maturity in a small swift stream near North Spencer on May 23rd. This last stream contains many small flat rocks on its mud bottom, and the nymphs were with difficulty distinguished from the mud-clumps on the undersides of these rocks. By June 5th they had practically disappeared from this stream, only a few good-sized nymphs and many cast skins being found. They were likewise observed in great numbers in Salmon Creek (in a similar section of the stream) on July 6th, but were gone from here by July 13th—indicating that week to have been the height of their season in that particular stream. They were collected by Dr. Needham as late as August 30th, in Elk River, West Virginia. The nymphs were fairly common in Cascadilla Creek, Slaterville, and North Spencer.

Ephemerella deficiens Morgan

The nymphs taken of this species were very black with a light mid-dorsal line extending from the anterior margin of the prothorax to the posterior margin of the metathorax. The gills, tibiæ and tarsæ are white. In alcohol the blackness of the body fades into a dark brown, and the light mid-dorsal line becomes almost indistinguishable.

Mature nymphs were first taken in the shallowest and most rapid waters of Cascadilla Creek on June 8th. Many full-grown nymphs were obtained from Salmon Creek in a similar sort of habitat on July 6th, and were gone from this stream by July 13th. They were collected as late as August 3rd in Fall Creek.

The subimago of E. *deficiens* is very dark in color, the wings being smoky.

Ephemerella dorothea Needham

Imago:

The imagos reared seem to be 1-3 mm. larger than those of Dr. Needham's original description[1]—the average body length of the male being 7-8 mm., of the female 8 mm. The ocelli of both male and female imagos are ringed at their bases with black.

Subimago:

The wings of the subimago are subhyaline in color with a tendency to turn black around the edges just before the subimaginal molt.

Nymph:

The nymph is much like *E. rotunda* in general appearance, although smaller and without dorsal spines. The two were frequently found associated together amongst the vegetation and moss accumulated around the stones of fairly rapidly flowing streams. The seasonal height in abundance and maturity of *E. dorothea,* however, seems to be a few weeks later than that of *E. rotunda*—the former being in its height in early June when the latter had already begun to disappear. The nymphs were collected as early as May 23rd in the North Spencer Stream, and were found to be fairly common (though never as much so as *E. rotunda*) in most of the local streams.

[1] N. Y. State Mus. Bull. 1908, 124: 190.

Ephemerella rotunda Morgan

Male adult: (reared from nymphs collected in Cascadilla Creek, Salmon Creek, Otter Creek, Van Buskirk's Glen, North Harford Brook, North Spencer Stream and Fall Creek).

Measurements: Body 9 mm., tails 12 mm., foreleg 9 mm., fore wing 10 mm. Head light brown; compound eyes orange-brown. Thorax and abdomen a shiny medium brown. Legs yellowish or tan. Tails ringed with dark brown at the base of each segment. Axillary cords of the fore wing prolonged into slender spines projecting posteriorly on either side of the hinder lobe of the mesothorax. Wings hyaline. Penes with stout spines.

Subimago: Wings subhyaline.

Nymph: (dark variety).
(Taken in Cascadilla Creek, Otter Creek, Salmon Creek.)

Measurements: body 9-10 mm; tails 6 mm. Head smooth and round; labium grayish in color. Thorax broad and flaring, the wing pads descending well over the first several abdominal segments; frontal angles of the prothorax with a prominent tooth, lateral margins with a broad thin shelf-like edge; front angles of the mesothorax with a prominent triangular tooth. Posterior angles of the head forming almost right angles. General color of abdomen blackish-brown, segments 5, 6 and 7 yellowish in color. Dorsal spines very well developed, occurring on segments 2-9. Lateral margins of segments 3-9 acuminate and slightly incurving, acuminate but not incurving on 10. Legs short and stubby relative to body; yellowish in color, the tibia and tarsus with dark brown bands. Gills present on abdominal segments 3-7, the 7th gill almost completely covered by the 6th. Tails lightish with several slightly darker bands, and with circlets of stiff hairs at the bases of the segments; fringed with longer hairs for the last two-thirds of their length. These longer hairs gradually diminish in length

toward the tips of the tails, which appear practically hairless.

Nymph: (light variety).

(Taken in Cascadilla Creek, Salmon Creek, Otter Creek, Van Buskirk's Glen, North Harford Brook, and North Spencer Stream.)

Measurements: body 10 mm., tails 6 mm. Head and body rounded and smooth. Posterior angles of head indrawn. Labium not marked with grayish as in the dark variety. General color light brown, tibia and tarsus banded with light brown. Front angles of the prothorax only slightly rounded, lateral margins only slightly flaring. Dorsal spines present on segments 4-9, but not so well developed as in the dark variety. Sometimes very slight spines can be detected on segments 2 and 3. Gills present on segments 3-7, the 7th gill not being so completely covered by the 6th as in the dark variety.

I do not feel that these two are different species, but regard them merely as color varieties of *E. rotunda.* The differences seem to be a matter of degree, with intergradations of such characters as the prominence of the dorsal spines, the extent to which the 6th gill covers the 7th, the toothing of the prothorax and metathorax, and the flaring of the lateral prothoracic margins. This species seems to exhibit many variations in color—from the very dark variety described above, to a light yellow variety with dark markings whose essential characters are the same.

E. rotunda was the most common and abundant member of the genus in the Ithaca streams from early March until late May. It was the earliest nymph collected, being found in great numbers and fully matured as early as March 16th. The last nymphs were seen in the North Harford Brook on June 11th. Although Miss Morgan and several others had never found the males of *E. rotunda,* I was able both to collect and to rear many. I did not notice any particular scarcity of males, the sexes being fairly equally distributed where the nymphs were obtainable at all. The male adults

of the light and dark varieties showed no differences when reared, which further convinces me that they are the same species.

The nymphs of *E. rotunda* seem remarkably varied in their choice of habitat. Although most usually found in the mud-gathering moss of flat rocks on the bottoms of fairly rapid streams, they were also collected in all intergrading types of streams from shallow riffles to the rather sluggish sections of deeper streams. This variety of habitat may be in part responsible for the variety of coloration and pattern displayed by this nymph, and even for some of the minor structural differences mentioned in the above descriptions.

Ephemerella septentrionalis McDunnough

Imago:

Measurements: body 10 mm.; tails 12 mm; foreleg of male 16 mm., fore wing 10 mm. (Measurements of female same, except for foreleg). Compound eyes of the male orange-brown, thorax yellowish. First seven abdominal segments grayish, 8th yellowish-gray, 9th and 10th yellow. Head, thorax and abdomen of female yellow; legs yellow. Compound eyes grayish and small; ocelli reddish-brown.

Subimago:

Wings subhyaline.

Nymph:

Measurements: body 10 mm; tails 7 mm; foreleg 6 mm. Head smooth except for a tuft of hairs on either side of the mid-frontal line of the apex. General color of thorax and abdomen light brown with a narrow brown mid-dorsal line. A row of brown dots on either side the median ventral line of the abdominal segments, and one at the base of each leg on the ventral side of the thorax. Legs extremely long and slender in proportion to the body. Tarsi with a band of brown. Gills present on abdominal segments 3-7. Dorsal spines absent. Lateral spines on segments 4-9. Tails light,

the segments surrounded at their bases with a circlet of stiff bristle-like hairs.

This nymph was collected only in North Harford Brook on May 16, 17 and 21. It had disappeared from here by June 23. It was collected from the mud-gathering roots of the vegetation along the edges of the stream in fairly great numbers, and was usually buried so deeply in the mud that it was difficult to discern and capture.

HYPERASPIS PALUDICOLA SZ.

Described from Florida. For many years I have owned a specimen doubtfully named as above, which bore the label "Provincetown, Mass.," without other information. On examining the catch of July 5, 1930, made at Dennis, Mass., I found several specimens of the same thing, and have now come to the conclusion that this is another of the many instances of the occurrence of southern species of beetles in the sand plain area of Massachusetts.

HYPERASPIS DISCONOTATA MULS.

This beetle was described from "L. Sup.," and one record appears in the N. Y. List from "Cascade. Aug."

I took one specimen by sweeping grass on June 5, 1927, and one on May 31, 1930, probably by sweeping in the same meadow in Sherborn, Mass.

C. A. Frost, Framingham, Mass.

NOTES ON SOME MOTHS COLLECTED AT SILVER LAKE, CHESHAM, NEW HAMPSHIRE

By Alexander B. Klots

Cornell University

From July 14 to 18 inclusive the writer collected moths at light on the west side of Silver Lake, near Chesham, N. H. A complete list of the species taken would seem unnecessary, but a number of the records are liable to be of interest to students of the distribution of New England Lepidoptera.

The nomenclature followed is that of the New York State List of Insects. All identifications have been checked with the collection of the Cornell University Department of Entomology, and doubtful cases with the collection of the U. S. National Museum. The writer is indebted to Dr. W. T. M. Forbes and Messrs. August Busck and Carl Heinrich for checking (and in some cases correcting) many of his determinations.

Tineidae

Tinea sp. near *croceoverticella* Chamb., but much smaller.

Lyonetiidae

Bucculatrix canadensisella Chamb. Very common.

Gracilariidae

Gracilaria bimaculatella Ely.
Gracilaria packardella Chamb.
Gracilaria serotinella Ely.

Gelechiidae

Gnorimoschema petrella Busck.
Duvita tahavusella Forbes, 2 specimens.
Telphusa fuscopunctella Clem. Common.

Aristotelia rubidella Clem. Common. This species has been confused with *pudibundella* Z. The male has a prominent sex-patch on the under side of the front wing.

A. absconditella Walk.

A. quinquepunctella Busck.

Enchrysa dissectella Z.

Evippe prunifoliella Chamb.

LAVERNIDAE

Perimede erransella Chamb.

YPONOMEUTIDAE

Ocnerostoma pinariella Z.

TORTRICIDAE

Olethreutes osmundana Fern.

Sparganothis lycopodiana Kearf.

Tortrix packardiana Fern.

PYRALIDIDAE

Polloccia alticolalis Dyar. Common.

Paralispa terrenella Z.

Elophila plevie Dyar. Very abundant. I have also taken this species in abundance at East Killingly, Conn. I cannot understand why its occurrence in the North has been so long overlooked. Type in the U. S. N. M.

Glyptocera consobrinella Z.

Meroptera unicolorella Hulst.

NOCTUIDAE

Parahypenodes quadralis B. & McD.

Panthea furcilla Pack. Very common! One specimen was a partial gynandromorph, the left wings and antenna being male, while those of the right side are female. The abdomen and genitalia appear to be normally male.

Plusia alias Ottol.

Eriopus mollissima Guen.

Eurois (*Matuta*) *youngii* Smith. Specimens were taken which intergraded strongly to *E. elimata* Guen., which was also taken. There appears to be some doubt that these are distinct species.

MOSQUITO CONTROL IN MASSACHUSETTS[1]

By George S. Tulloch

Previous to 1929 little attention had been given to the control of mosquitoes in Massachusetts. Various municipalities through their local boards of health had inaugurated campaigns for the control of the common house mosquito, *Culex pipiens*, and in a few instances communities along the sea coast had directed some attention to the control of the salt marsh mosquito *Aëdes sollicitans*.

In 1911, through the efforts of a group of citizens of Ipswich, on the North Shore of Massachusetts, the ditching of a large area of salt marsh practically eliminated breeding pools in that particular region. Since the area ditched was only a small portion of a large salt marsh, the benefit derived was of little value, as the extensive flight range of *Aëdes sollicitans* permitted infestation from adjacent areas. However, the permanence and practicability of mosquito control by ditching was clearly shown by this project, for the ditches are still functioning properly, and that section of the marsh is in nearly a non-breeding condition after nineteen years of periodical flushing by the high course tides.

In 1929 the State of Massachusetts through its Reclamation Board took an active interest in the problem of mosquito control. This Board, comprised of three men, acting in an advisory capacity, cooperated with various towns in the salt marsh areas and suggested control measures. Under the State Reclamation Board groups of cities and towns are authorized to cooperate by forming a mosquito control project directed by commissioners appointed by

[1]Given before the Entomological Society of America at the Case School of Applied Science, Cleveland, Ohio, December 30, 1930.

the board. Money appropriated by the members of the project can then be spent for the benefit of the project as a whole, without being restricted by town or city boundaries. Adopting this method money was available for actual ditching operations early in 1930.

The island of Nantucket was the first to start operations in April. This island, covering approximately fifty square miles, is situated twenty miles from the southern coast of Cape Cod and about twelve miles from its neighbor, Martha's Vineyard. Its isolated position outside the normal flight range of *Aëdes sollicitans* (the prevalent mainland mosquito) made it an ideal spot to demonstrate the practicability of mosquito control by ditching. The area of salt marsh on the island was 838 acres, while fresh water swamps included over 1300 acres. The salt marsh area was treated first, and over 300,000 feet of ditches, ten inches wide and 24 inches deep, were constructed before it was considered to be in a non-breeding condition. Then attention was directed to the fresh water areas. Here the topography of the island did not permit the accomplishment of mosquito control by the simple means of ditching. In some cases culverts and underground drains were constructed and in a few instances it was necessary to resort to oiling, but in general, whenever possible, permanent control measures were effected. The presence of *Mansonia perturbans,* the larva of which attaches itself to roots and stems of aquatic plants, added to the problem, since it only can be controlled by completely removing the water, a method which oftentimes is impracticable.

The control measures carried on at Nantucket have reduced mosquitoes and added much to the comfort of the residents. In addition land values in some regions have increased twofold or more.

The success of the Nantucket project encouraged the Cape Cod Chamber of Commerce to inaugurate a drive to raise funds to carry on the control work on a more extensive basis than that provided for by local appropriations. Two hundred thousand dollars were pledged by public subscription, the money to be spent over a period of three

years, seventy thousand dollars of which became available in August, 1930. Extensive operations were started immediately, and at the present time over 1,000,000 feet of ditches have been dug and the worst breeding areas eliminated. By May, 1931, it is estimated that an additional 500,000 feet will be completed.

In addition to these projects the State of Massachusetts through its Department of Public Works has built a dike, 3,000 feet long and about five feet high, across Race Run at Provincetown, on the tip of Cape Cod. This dike now prevents the tide waters from reaching an area six hundred acres in extent, formerly known to be a prolific breeding-place of salt marsh mosquito. The cost of construction of this dike was assumed by the State, being on land owned by the Commonwealth. In this case, through its Department of Public Works, and also through its Reclamation Board, the State of Massachusetts again has shown her foresight in taking advance steps toward the comfort and prosperity of her citizens.

THE BIOLOGY OF THE MECOPTERA

By Frank M. Carpenter*

Among the curious phenomena of nature none is more unfortunate than the close correlation which exists between the number of species in an insect order and the number of entomologists concerned with it. The entomological world is filled with students investigating the classification, economies, society, pathology, eugenics, intelligence and morals of the Hymenoptera. Our National Parks and Forests are menaced annually by coleopterists, destroying the natural geology and tearing the barks from the trees in their search for new species. The Lepidoptera, especially the more attractive groups, are gradually becoming extinct, because of the enthusiastic quest for aberrations and queer varieties. But the smaller orders of insects are rarely the object of biological or taxonomic investigation. A list of the neuropterists in all the world would not equal a list of the coleopterists in some of our larger cities.

This evening I propose to discuss the habits and life-history of one of the smallest and therefore most neglected orders of insects—the Mecoptera, or scorpion-flies. Many of you have probably never seen one of these insects outside a museum, for they are very seclusive. They fly seldom and for short distances only, and usually keep close to the ground. When disturbed they either dart to the ground and hide among the dead leaves, or they fly to the under surfaces of the leaves and branches of shrubs, where they can be seen only with difficulty. So far as humans are concerned they are entirely inoffensive: they do not feed upon valuable crops, they have no selfish desire for human

*Address of the retiring president of the Cambridge Entomological Club, January 13, 1931. Contribution from the Entomological Laboratory of Harvard University.

blood, and they do not transmit disease, although I have several specimens of *Panorpa lugubris* from Nichols, South Carolina, which were held responsible by the inhabitants of the town during the fall of 1928 for an epidemic of fits among the dogs.

Because of their seclusive habits the scorpion-flies apparently escaped the attention of the ancient and early medieval naturalists more persistently than most other types of insects. According to Figuier,[1] Aristotle thought that the males of the Panorpidæ were flying scorpions because they possessed a swollen bulb at the end of the abdomen resembling the poison sac of the true scorpions. But I consider that this statement is incorrect, for Aristotle was one of the few ancient naturalists who believed that scorpions could not fly.[2]

Pliny the Elder, however, quoting Appoloderus of Athens (144 B. C.) states in his "Natural History" that some scorpions have wings, and it is possible that these flying scorpions were in reality males of Panorpidæ. Definite references to the scorpion-flies seem to be absent from all the so-called encyclopedias and natural histories of the Middle Ages until 1605, when Ulissi Aldrovandi published the insect volume of his "De Animalibus." In this work there are the first recognizable descriptions of Mecoptera, which he placed with the flies, and there are several good figures of Panorpas, showing the elongate beak and other characteristic features (fig. 1A). In 1634 there appeared the "Insectorum sive Minimorum Animalium Theatrum," which is usually attributed to Thomas Moufet. This interesting compilation was originally begun by Edward Wotton, a prominent English physician of about 1550, and was continued by Conrad Genner, Thomas Penny, and Moufet. On page 62 there are three figures of Panorpas, depicting clearly the genital forceps of the males (fig. 1B). The illustrations used in both these works were later republished by Johannes Johnston in his "Historia Animalium," which appeared in 1653. All these figures are really remarkably accurate, and

[1] Les Insectes, 1st ed., 1867, p. 512.
[2] De Partibus Animalium, Bk. 4, Ch. 3, p. 123.

seem especially realistic when they are compared with the serious reproductions of dragons and hydras which are included in the serpent section of Johnston's volume. Linnæus, whose tenth edition of the Systema appeared a little more than a century after Johnston's publication, described only three species of scorpion-flies, placing them in the genus Panorpa of the Neuroptera. About a quarter of a century later (1801) Latreille decided that they required a separate family, which he called Panorpatæ.

Fig. 1. Early illustrations of scorpion-flies:
A (5, 9), from Aldrovandi's *De Animalibus,* 1605;
B, from Moufet's *Insectorum sive Minimorum Animalium Theatrum,* 1643

In 1886 Packard erected the order Mecaptera for them, in reference to the long wings; and in 1895 Comstock changed the name to Mecoptera, the form in which it has subsequently been used. At the present time five families of the order are usually recognized: Notiothaumidæ, including a single species, which is restricted to Chile; Meropidæ, also including a single species, found along our Atlantic coast from Maine to Georgia; Panorpidæ, consisting of about 250 species and being generally

distributed over the holarctic regions, with a few representatives in the Australian, Oriental, and Neotropical zones; Bittacidæ, containing about 60 species, which occur in all parts of the world; and Boreidæ, with about a dozen species confined to parts of the Nearctic region and the western edge of the Palearctic.

In a group of insects as primitive as the Mecoptera we should expect to find simple and uninteresting habits. But during the two hundred million years since the first appearance of the order in the lower Permian rocks, there has been ample time for the development of peculiar traits in habits, even though the insects have undergone few structural changes. Unfortunately, nothing is known of the habits of Notiothauma and Merope, except that the latter is positively phototropic. Curiously enough, those habits of the other Mecoptera concerned with courtship and mating show the highest development and diversity; the courtship of the Panorpidæ involves peculiarities which have been found in few other groups of insects. The male Panorpa, on approaching the female, vibrates his wings rapidly and the female usually responds in like manner. Then the male stretches out his abdomen, seizes that of the female with his strong genital forceps, and then moves the forceps along until the female genitalia are reached. During copulation the bodies of the two insects diverge in the form of a "V." Usually the insects remain *in coitu* for a quarter of an hour or even an hour. Campion (1915)[3] observed a pair of *P. germanica* which started to mate at 11:30 A. M. and continued all day; at night when several aphids were introduced into the box, the pair fed together, while still in copulation. Miyaké (1913) has made some interesting observations on the mating habits of *P. klugi:* "One male is usually surrounded by two or three females which seem to the observer to be coquetting with the male. I saw on June 5th a pair in copulation beside two females. At last one of the two (I think the stronger one) began

[3] References not given here will be found in the bibliography of my revision of the Nearctic Mecoptera, now in press (Bull. Mus. Comp. Zool.).

to disturb the pair in copulation, using its long beak as a weapon, and succeeded in separating them. The successful rival then effected a pairing on the spot."

The most interesting feature of the mating habits of Panorpa concern the salivary glands of the male. Brant (1839) and Dufour (1841) observed in their anatomical studies of certain neuropterous insects that the salivary glands of the male Panorpas were much larger than those of the females. Mercier (1915) studied this peculiarity more carefully in *Panorpa germanica, alpina,* and *cognata,* with surprising results. He found that the salivary apparatus in the male consisted of two glands, each of which was composed of three long, filiform branches, and which opened into a common reservoir. The two reservoirs in turn opened into a common excretory duct. This complex structure was not developed until the male was four or five days old, at which time sexual maturity was reached. During the first few days after emergence of the male from the pupa the glandular tubes were only two or three millimeters long, but in eight days they had reached the length of 12 millimeters. Mercier observed that when a male, with its wings vibrating, approached a female, it suddenly ejected from its mouth a small drop of liquid, which coagulated almost the instant it was expelled, forming a small opaline pellet about the size of a pinhead. The male then moved several centimeters away from the pellet and again vibrated its wings. The female advanced and fed on this ball of saliva, whereupon the male rapidly approached, grasped her abdomen with his forceps, and entered into copulation. During the whole process the female continued to feed on the excretion, which (according to Mercier) it dissolved with a brown liquid. As soon as the first pellet of saliva was consumed, the male ejected another one, which was likewise devoured or dissolved in a similar manner. This process continued as long as the two were paired. Mercier believes that this excretion helps the male to secure a mate. Shiperovitsh (1925) has repeated Mercier's observations on *P. communis,* although there seem to be some points of difference, for the males of that species

ejected several cylindrical pellets, instead of drops of saliva. It is probable, however, that Shiperovitsh did not examine the drops until they had hardened. This particular type of bribery on the part of the male is, I believe, unique among all the insects, inasmuch as it involves a product of the digestive system. But the dipterous family Empidæ is famous for the peculiar tactics employed by the males, who offer the females particles of food as a preliminary to mating, although some degenerate and more modernistic species have reduced their gifts to inedible debris, such as small pebbles and bits of wood. In a very different group of insects, the cockroaches, we find another instance, more unlike that of the Panorpas. The males of Œcanthus, as shown by Hancock, possess a gland in the center of the metanotum, which secretes a fluid apparently much desired by the female. Just before actually mating the female climbs on the male's back and inserts her mouth at this gland, devouring the secretion ravenously. Unlike the condition in Panorpa, the feeding must end before copulation begins.

The mating habits of the other genera of Panorpidæ besides Panorpa are not known sufficiently to enable us to determine whether on not the males employ similar devices during courtship. Tillyard has made a few observations on the Australian genus Chorista, but has mentioned no such tactics. "If a male and a female be put alive into a glass tube, the male at once seizes the female fiercely with his anal forceps, taking hold of her in any position haphazard. He then quickly moves his appendages to the posterior end of the body of the female, opening his forceps to a great width, and then closing them quickly upon the tip of the abdomen. The result is a lock-grip, the two insects facing opposite directions. When once the male has got his correct hold, no amount of annoyance will persuade him to let go."

The Bittacidæ have apparently not developed any specialized habits in connection with mating; at least, no one has recorded such behavior. Mercier, however, mentions incidentally that the males of Bittacus present the females

with particles of food, as a part of courtship, as in the Empidæ; but he does not imply that he has actually seen this done, and he gives no reference to a published account. Miyaké has noted that the males retain the body of a victim for some time after they have finished with it, possibly as a lure to the females, who "come and try to take away the bait," whereupon the males attempt to mate with them. Such behavior, unless carefully observed, might easily be misinterpreted and be the basis of Mercier's remark. During copulation the specimens of Bittacus hang suspended from the branches or leaves, facing each other ventrally.

The snow scorpion-flies of the family Boreidæ have no mating habits like those of Panorpa, although the act of mating itself is a very curious process, and demonstrates the function of the bristle-like wings of the males, as shown by Withycombe. When a male becomes enamoured of an attractive member of the opposite sex, he runs along at her side for a short distance; then, by a series of sudden movements he grasps her near the base of her abdomen with his hooked wings and pulls her upon his back. Next he pushes her around into a more comfortable position, until he is able to seize her abdomen with his forceps and bring about copulation. Then he releases the hold with his wings and "wanders about on the surface of the ground with the female seated on his back and apparently helpless." This manœuver has been observed by Cockle (1908) in *Boreus californicus,* and by Withycombe (1926) in *B. hyemalis.*

The feeding habits of the adult scorpion-flies have been the cause of considerable discussion and the object of several investigations. The earlier writers thought that the Panorpidæ were exclusively predacious, and this view has persisted until within very recent years. Lyonnet started the notion in 1742, in Lesser's "Theology des Insectes ou Demonstration des Perfections de Dieu," where he states that he saw a fly of the size and appearance of a scorpion-fly attack a damsel-fly ten times its own size, and bring it

to the ground. The Odonatan was unable to repel its aggressor, and would have perished from the repeated thrusts of the scorpion-fly's beak, had not Lyonnet interfered. Kirby and Spence (1828) describe this encounter in the fifth edition of their "Introduction," and state without reserve that the offending insect was *Panorpa communis*, although there was certainly no evidence for this conclusion; and in view of the more recent observations it seems clear enough that this "tyrant of insect creation" was not a Mecopteron. Brauer (1863) fed adult Panorpas on bits of meat and on insects which had just been killed. In the "Feuille des jeunes naturalistes" for 1880 there is an anonymous note describing several specimens of *Panorpa communis* which were eating portions of fish that had been placed upon a bank near a stream. Felt (1896) fed adults of one of our American species, probably *P. canadensis*, on injured lepidopterous larvæ, and he was also able to keep one female alive for eighteen days on a diet of fresh meat. He believed, however, that only the juices were consumed. Poulton (1906) saw several European species of Panorpa feeding on other Arthropods, but the latter were dead when he first examined them. He suggests that the scorpion-flies feed only on dead prey. Lucas (1910) mentions one Panorpa which was feeding on a "whitish grub." Campion (1915) concluded from several experiments on *P. communis* and *P. germanica* that they feed on dead or nearly dead animal matter. Miyaké (1912) was convinced from his extensive studies on the Japanese *P. klugi* that the food of Panorpas usually consists of dead or injured insects, although he saw one female attack a living and healthy larva of its own species. Shiperovitsh (1925) states that all the investigations on the subject prove that the adults of Panorpa are exclusively saprophagous. However, the term "saprophagous," if so used, must be understood in a very broad sense, for the injured insects and fresh meat used by the authors mentioned above could hardly have started to decay by the time they were devoured by the Panorpas. Also, it must be remembered that some adults have been seen feeding on the nectar of flowers and on

fruits, and Miyaké notes that several of his specimens fed on the petals of Sweet William (*Silene armeria* Linné); in every case the entire petal was affected and later wilted. The sum of all these observations seems to me to suggest that the various species or species groups of the genus have widely different sources of food.

The Bittacidæ are essentially predacious and their legs are modified for grasping and holding prey: the femora and tibiæ are covered with strong spines, the tarsal joints are very flexible, and the single tarsal claw can be bent back against the rest of the tarsus. Bittacus is a slow-flying creature and it rarely if ever catches prey in flight. It usually remains motionless under a leaf or twig for many minutes or even hours, until another insect alights within reach of its legs. Then it suddenly reaches out and grasps the victim with its tarsus. When the captured insect has been turned into a satisfactory position, it is carried within reach of the beak, which usually penetrates between the abdominal segments or at the junction of the head and thorax. Probably only the juices are consumed. Soft-bodied insects, like the Diptera, seem to be preferred as food, but Hymenoptera, Hemiptera, Lepidoptera, and even Coleoptera are frequently taken as well. Miyaké has found that the Japanese Bittacus will feed on dead insects, decayed leaves, and even soil. The process by which a slow moving Bittacus attacks and devours active or even stinging insects is a most fascinating one. A splendid description of such an encounter between an Australian Bittacus and a bee has been given by Jarvis (1908) and is worth quoting in full: "Whilst standing by a large bush of *Daviesia corymbosa,* watching the number of specimens of bees that were attracted by the blossoms, I heard a sudden loud buzzing, louder than that caused by the continuous murmur of the bees, and saw that a specimen of *Bittacus australis* had just seized a large honey-bee which was making frantic but ineffectual struggles to escape from its clutches. It had grasped its victim with both hind legs and was holding it as far as possible from its body, with the flexible tarsi wrapped around the unfortunate bee and

working continually, just like the fingers of a hand, to prevent it from turning towards its enemy. In such a position, with its back to the fly, the poor insect was unable to make any use of its sting, and all efforts to twist around were anticipated and prevented by the movements of the numerous sharp spines of the encircling tarsi. Some muscular effort is doubtless required to enable the fly to keep its hind legs in an extended and rigid position in spite of the struggles of the large, winged insect, which may account for their being larger and stouter than the others, with the femora being somewhat incressated and the tarsi being larger and more powerful. So intent was it upon securing its prey that I was allowed to examine its every movement minutely, and whilst wondering what would happen next, it suddenly put out its two mid-legs and caught the tips of each primary wing of the bee between the last two joints of the tarsus, in much the same manner as we should take hold of anything between our finger and thumb, and pulled them out to their fullest expanse, thus effectually preventing the last remote chance of escape by these organs of flight. The scorpion-fly was now hanging from the bush by its two arms, and holding its prey with extended wings and body still grasped by the hind tarsi. And now came the closing scene of this insect tragedy; the hind legs slowly contracted to bring the body of the victim nearer, and the cruel, beak-like mouth approached, and, after hovering close to it for a few seconds, was inserted between the head and prothorax of the bee, which was unable to make the slightest resistance while its captor was piercing and biting through the slender, fleshy neck."

Of all the Bittacidæ, certainly the most curious is the Californian *Apterobittacus apterus*, which is completely devoid of wings and resembles a phylangid with a pair of legs missing. But this creature is nevertheless as successful at catching prey as its winged relatives. It replaces its want of wings by great dexterity in climbing, swinging itself monkey-like from twig to twig, often supported by one tarsus. Osten-Sacken (1882) once observed a speci-

men devouring a tipulid with vestigial wings,[4] and he suggests a possible mimicry of this species on the part of the Bittacid.

The feeding habits of the Boreidæ have been more or less obscure until recently. Brauer observed that the adults fed on moss, as well as on Produra and other small animals living among the moss roots. Whitycombe concluded from investigations which he made in 1921 that they fed on damaged or dead insects, although he found some specimens feeding on the bases of moss plants. Subsequently, however, he made further inquiries into the feeding habits and decided that the food is normally moss, although in captivity, when proper food is not available, other substances may be consumed. He also found that the amount of food needed was very slight, but a great deal of moisture was required.

In the preceding pages we have reviewed what is known of the habits of the adult Mecoptera, and we shall next consider the main features of their metamorphosis. Here again, we have no knowledge of the life-history of the Meropidæ and Notiothaumidæ, and our acquaintance with the development in the other families is almost entirely confined to old-world species of Panorpa, Bittacus, and Boreus. Curiously enough, Swammerdamm, who investigated the metamorphosis of many groups in 1669, including some Neuroptera and Trichoptera, apparently made no observations on the Mecoptera. The earliest research of this kind was done in 1831 by Maquart, who briefly described the pupa and showed that it was the *libera* type. The pupa was also described and figured by Stein in 1838, and the complete life-history of three European species (*P. variabilis, montana,* and *communis*) was worked out by Brauer in 1863. Some of the larvæ and pupæ which he bred sixty-seven years ago are now in the Hagen collection of the Museum of Comparative Zoology. In 1894 Felt succeeded in rearing the larvæ of a Panorpa (probably *P. canadensis*) at Ithaca, New York, but he was not able to obtain a pupa.

[4] Dr. C. P. Alexander tells me that this species is almost certainly *Tipula vestigipennis* Doane.

This is the only account published on the life-history of a New World Panorpa. Miayké has carried out some splendid studies on the Japanese *klugi,* securing all stages; and Shiperovitsh has more recently reared two European species, *communis* and *cognata.* The following discussion of the metamorphosis of Panorpa is based largely on these investigations, supplemented by a few observations of my own on *P. maculosa* Hagen.

The eggs are spherical or oval, and usually white; they vary somewhat in size, depending on the dimensions of the species, but are usually less than a millimeter long. Normally they are laid in the soil in clusters of various sizes, including as many as 97 eggs. The eggs have an extremely thin shell and require a great deal of moisture for development. I have had eggs of *maculosa* dry up and shrivel within a couple of hours from the time they were deposited, when they were exposed to the normal atmosphere, even though placed on a non-absorbent surface. In about 6 or 8 days the larva within the egg pushes up the shell at one pole with the frontal part of its head and, after the shell has broken away, it unrolls itself and crawls out. In comparison with the size of the egg the larva is quite large, about 5 millimeters long. On emergence it has a pure white body, a yellow head, and pink eyes; but in a few hours these colors darken. The antennæ are small, consisting of 4 short segments, but the eyes are large and composed of about 25 ocelli. There are 3 pairs of thoracic legs, each consisting of 4 segments, and there are also 4 pairs of abdominal prolegs. The first 9 abdominal segments bear a pair of stout annulated spines, those of the eighth and ninth segments being much enlarged. The tenth segment possesses a single, very long spine, projecting posteriorly. The larvæ probably pass through seven instars in about two weeks' time, although Shiperovitsh claims that there are only four instars in *P. communis.* During these stages the larva undergoes very few changes: the abdominal legs become relatively shorter, the head smaller, and the spines on the abdominal segments are greatly reduced. The larvæ feed readily on fresh meat, fish, or injured insects; and

according to Felt, some of the larvæ are predacious, the larger ones sometimes attacking and devouring the smaller. Usually the larva forms a short burrow in the soil, but it may leave the burrow entirely and feed above the ground. The last instar of the larva is much longer than the others, usually lasting about a month, and this appears to be the hibernating stage. The pupa is formed in a cell constructed in the soil by the last instar larva. It is characteristic of the *libera* type, as found by Maquart, the appendages being free, though immobile. The antennæ and legs are like those of the adult, but the mouth is not prolonged into the beak and there is no genital bulb in the male. In about a week or ten days the pupal case ruptures in the usual fashion and the adult makes its appearance. No observations seem to have been made on the condition of the adult as it emerges, or on the amount of time which elapses before it is able to fly. The adult Panorpas usually prefer dark and rather moist woods, or sometimes more open areas which are low and near water. In New England I have found them most abundant in woodlands containing *Myrica asplenifolia* and associated plants. In the more central and southern states they frequently inhabit open fields; and in the Smoky Mountains of Tennessee I have found a new species to be most abundant on the very edges of a rapid stream, and even resting on the bare rocks in the middle of a large creek.

Much less is known of the life-history of Bittacus than of Panorpa. No one has secured the larva or pupa of an American species, and Brauer alone has succeeded in rearing a species through all stages of development. He found that the eggs are laid in small clusters within the soil during the fall and remain over the winter in that conditon; but both Felt and Miyaké observed the females drop their eggs singly at random while flying over the soil. According to Brauer, if the soil in the egg chamber dries up in the late fall, the eggs hatch the following April; but if the soil stays moist, the eggs remain over until the spring of the second year following. The larvæ live above ground, among leaves and grass, not in the soil like those of Panorpa. Brauer fed

his larvæ on raw meat, but he did not determine the natural feeding habits. The larvæ are much more spiny than those of Panorpa and are considerably stouter. They are also more active than the Panorpas; when frightened or disturbed they roll themselves up in the manner of many lepidopterous larvæ, or they throw the anterior part of the body in an erect position, much like the sphingid larvæ. About ten days before pupation the larvæ bury themselves in the soil and form a chamber. The pupæ are similar to those of Panorpa in general appearance, although of course they are very slender and have the habitus of a Bittacus. The adult emerges in about two weeks. Brauer states that the adult of *B. italicus* forms a chamber of leaves or twigs and lives within, feeding on the insects which are unfortunate enough to enter. No such chamber has been observed in the case of the American species, and I am certain that none is used by *B. strigosus.* One species of the genus, *chilensis,* is decidedly cavernicolous. The Bittacidæ are usually very local in their distrbution; in New England *strigosus* can frequently be taken in woodlots less than an acre in extent, but will not occur elsewhere for miles around. Martin (1892) has shown that *B. tipularius* occurs very irregularly in France; in some years, as 1888, it may be very abundant, literally covering the "wheat, clover, broom, heath and thicket," although in a few years' time it may be almost entirely absent. He attributes this decrease in the number of specimens to the corresponding increase of a parasite, although none has ever been found in Bittacus or Panorpa. Certain species of Bittacus, at least our *occidentis* and *strigosus,* are positively phototropic and are frequently caught in light traps.

The life-history of Boreus was also worked out by Brauer (1862), but he did not succeed in carrying any one species through all its stages of development. Additional observations have been made by Williams (1916) and Withycombe (1924, 1926), who has given a splendid account of the biology of the European *B. hyemalis.* The eggs are laid one or two at a time among moss roots. The larvæ hatch in about ten days, usually during December; they possess

abdominal prolegs during the first instar (according to Brauer), but lose them later. There are at least four instars, during which time the larvæ feed on moss roots and liverworts. The full grown larva, usually about 6 or 7 millimeters long, is shorter and stouter than that of Bittacus. The larval stage is the longest, lasting from December to August, when the larva prepares for pupation by forming a vertical tube in the soil, nearly extending to the surface. The pupa is more active than the larva, rapidly wriggling up and down the tube when it is disturbed. After from 4 to 8 weeks the imagines appear. The adults may be found in the spring and early summer among moss roots and under stones, but they are only active in the winter, when on sunny days they can be seen hopping about on the surface of the snow, covering as much as 6 inches in a single leap.

From this survey of the biology of the Mecoptera I hope it is clear that our knowledge of the life-history of the American species of scorpion-flies is very meagre and that we have great want of further observations on their habits. This is particularly true of the remarkable *Merope tuber,* which inhabits only our Atlantic states. Perhaps one of you, while searching in the soil for a beetle or a member of some other large order, will be fortunate enough to stumble upon the larva or pupa of Merope, and thus fill in one of the most disconcerting gaps in our knowledge of complete metamorphosis.

SOME ORIENTAL NEUROPTEROID INSECTS

By Nathan Banks

Museum of Comparative Zoology, Cambridge, Mass.

Most of the species described below are from the Philippines, collected some years ago by the late C. F. Baker. Besides the new species there are descriptions of the curious Acanthaclisid (Madrasta), the only one known from the Malayan Islands, and of what I consider both sexes of an Osmylid recently published as new by Mr. Petersen from Ceylon. The types of the new species are deposited in the Museum of Comparative Zoology.

Psocidae

Hageniella pusilla sp. nov.

Body pale yellowish, head and notum with scattered short white hair; antennæ pale, with long gray hairs; legs pale. Wings hyaline; veins brownish. Beyond basal fifth of wing is a broad black band extending out to the areola postica and occupying half of stigma; end of anal vein and base of stigma with a black spot.

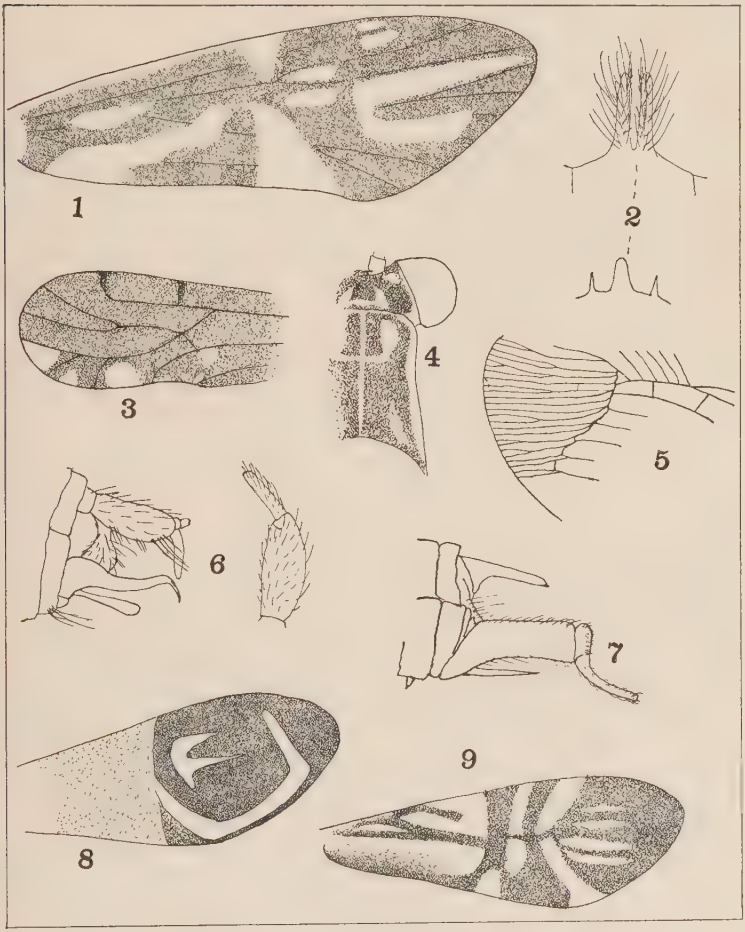
Radius and medius touching at one point, fork of radius about as far back as first fork of medius; areola postica scarcely twice as long as broad; fork of radius about equal to its stem.

Length 2.2 mm.

From Mt. Makeling, Philippine Islands (Baker).

The dark band across fore wing reminds one of *H. zonatus*, but in that species (which is much larger) the band is not one-third as broad, and paler; the areola postica longer, radial stem longer than fork, etc.

Psyche, 1931. Vol. 38, Plate 5.



Banks, Neuropteroid Insects.

Tagalopsocus hyalinus sp. nov.

Head yellowish brown, clothed with short white hair, thoracic notum darker (but not black), with still shorter white hair; antennæ pale, with moderately long hair; abdomen dark; legs pale.

Wings hyaline, veins yellowish brown, margin all around brown as in *T. luzonensis*, the margins and veins with many short hairs as in that species, the stigma is a little wider in the middle, and without the dark color of *T. luzonensis*, the stem of the radial fork is a little curved, and the veins of fork also more curved than in the other species, and lower branches of media also slightly curved. The areola postica is large and high as in that species.

Length 4.5 to 5 mm.

From Imugin, N. Viscaya; Surigao, Mindinao, Mt. Makeling, Luzon, Philippine Islands (Baker).

Ectopsocus aethiops var. **bakeri** var. nov.

Fig. 3.

This agrees with *E. aethiops* Hagen in the position of the pale marks, three along median cells, and one above anal vein. In this form the first and last of those in median cells are very large, and that above end of anal vein a good-sized, triangular spot; in the typical *aethiops* (Ceylon) the three along median cells are all very small and subequal, and that above end of anal vein reduced to a line.

Of the same size as typical form.

From Mt. Makeling, Philippines (Baker).

MYRMELEONIDÆ

Stenares frazeri sp. nov.

♀ Face pale, cheeks wth an inner dark streak next to the clypeus, mandibles and palpi dark, a dark band through bases of the antennae; vertex pale, with a median triangular black spot from behind and numerous (about 40)

small scattered dots; pronotum pale, a broad, median black stripe, broadened in middle, a lateral black mark, narrow in front, very broad behind, and in front of this, each side, a dark dot; rest of the notum pale, with median dark stripe, and shorter, narrower lateral stripes; legs dark reddish brown at base, nearly black at tip; abdomen dark, darkest at tip, above toward base mottled with pale.

Hair on thorax long, mostly white or gray, some brown in middle and on sides of notum, pleura with some brownish hair below, abdomen with long white hair at base, beyond with extremely short white appressed hair, some at tip dark; legs with short appressed white hair, and longer black bristles. Labial palpi elongate, last joint about as long as front femur; vertex much elevated, very slightly bilobed; pronotum more than twice as broad as long. Legs short, spurs equal two joints, four tarsal joints short nearly subequal, fifth equal others together. Wings long, rather blunt-pointed, much marked with small dark dots, marks much as in *S. improbus* but the stigmal spot broken up; hind wings also marked in front and behind much as in *S. improbus,* near hind margin a more or less broken streak; there is no trace of the three large spots in the middle area of *S. improbus.* The venation is like that of *S. improbus* except that the costal area of the hind wings is simple for about one-half its length.

Length of fore wing 67 mm., width 16 mm. Length of hind wing 63 mm., width 15 mm.

From Coorg, India, May (Major Frazar).

The several specimens of *S. improbus* that I have seen, as well as the type have the three large spots in the hind wing very distinct.

Nesoleon perpunctatus sp. nov.

Face yellowish, a black spot on clypeus, and the labrum mostly black, a black interantennal mark reaching below the antennæ and above extending up in front of vertex,

and continued back over the vertex as a median stripe; palpi pale; antennæ deep black; pronotum pale, with rather broad median black stripe and narrower lateral stripes remote from the margin and interrupted near front end; these three stripes are continued back over the rest of the notum, with a few additional short streaks, the scutelli with broad black stripe; pleura pale, with some black marks mostly on lower part; legs pale, femora dotted and the hind-tibia lined with dark; venter of abdomen black, above pale, with median dark stripe. Fore wings rather densely marked with many dark spots of about one size, nearly always at the junction of veins, but none on the banksian line; hind wings with many similar spots, mostly in the apical area and near posterior margin; stigma in both pairs large, distinct, pale yellowish. In both wings ten cross-veins before radial sector, latter with twelve or thirteen branches, in fore wings one of them looks like a separate radial sector; nine branches of first anal in fore wing, seven in hind wing; in both wings radial sector much beyond the cubital fork.

Length fore wing 34 mm., width 11.5 mm.

Length hind wing 29 mm., width 9 mm.

From Nandapur, Madras Prov., India, 27 October (Major Frazar).

Eophanes gen. nov.

In the fore wing the second anal vein runs close up to the first anal and then turns down and unites with the third anal for some distance; in hind wing but one cross-vein before the radial sector. The legs are slender, the femora cylindric, the front femora more than twice as long as the coxæ; at base of hind wing is a short vein closely parallel to hind margin and running into the branch of the second anal. In the fore wing the radial sector arises beyond the cubital fork; the claws are very long as in *Paraglenurus*. It differs from that genus in having the wings very much

broader, and in having the spurs equal to four tarsal joints.

Type: *E. formosa* n. sp.

To this genus probably belongs the *Formicaleo schladeri* of Van der Weele. The wings are much as in his figure, but the hind ones more acute at tip and outer margin concave. The marks of the vertex and pronotum are very different from his figure.

Eophanes formosa sp. nov.

Fig. 4.

Interantennal mark black, extending a little below antennæ and above reaching up on vertex, leaving a yellow spot each side between antennæ and eyes; vertex with a yellow spot each side, and two toward middle behind; antennæ rather pale, tip dark. Pronotum with lateral margins and a fine median line pale, two pale spots in front, and two smaller ones behind; rest of notum mostly dark, but with several pale spots, two on the anterior lobe, and each side on the scutelli; pleura mostly dark, a few pale spots. Legs pale, femora and tibiæ dark at tips, and the tibiæ also toward the base, tarsi dark at tips of joints, spines and bristles black; abdomen dark, apex of first and middle and apex of second segment pale above, hair short, black. Wings with venation black, with patches of yellowish ones, the subcosta with about three times as many dark spots as on the radius; stigma whitish, many veinlets in apical field pale, and in certain lights a white spot (larger than stigma) before apex; the apical forks are dark, and near rhegma are a number of dark veins tending to make a cloud. The hind wing is similar, but the cloud at rhegma is larger, almost reaching the margin, and there is another cloud beyond it; the subapical white spot is present as in fore wing.

Antennæ as long as head and thorax; the pronotum longer than broad. In the fore wings the radial sector arises a little beyond the cubital fork, seven cross-veins before the sector, twelve branches to the sector; in hind

wing the radial sector arises far before the cubital fork.

Length front wing 43 mm., width 13 mm.; length hind wing 43 mm., width 10 mm., abdomen 25 mm.

From Mt. Makeling, Luzon, Philippines (Baker).

Syngenes palpalis sp. nov.

Greatly resembling *S. longicornis* in structure and markings; the dark of vertex not connected to the interantennal mark, the lateral dark stripe of the pronotum shows less tendency to be double; the dorsum of abdomen with five bright yellow V-marks, the last two segments with median dark stripe and lateral marginal stripes. The labial palpi are much longer than in *S. longicornis,* the last joint twice as long as the last joint of the maxillary palpi (in *S. longicornis* but little longer). The wings are practically the same as in the African species, but the hind wings are rather broader.

Length fore wing 48 mm., width 12.5 mm.; length hind wing 43 mm., width 11.5 mm.

From Vizagapakan, Madras Prov., India (Major Frazar).

Madrasta handlirschi Navas

Fig. 5.

Face rather bright yellow, above antennæ and the vertex dull black, palpi and basal joint of antennæ yellowish; pronotum black, a faint median pale line, two spots each side in front, a spot each side on middle lobe, and a submedian pair at base, and the posterior outer edge pale; rest of notum mostly black, some small pale spots; pleura largely pale, a few dark streaks; abdomen black, pale on base below; legs mostly pale, front femora dark in middle, tibiæ with two spots near middle and sometimes at tip. Hair of body very long, mostly white, some dark, mostly on face, and middle of pronotum; hair on the abdomen short, appressed, except some long hair below near base each side. Labial palpi very long, last joint longer than space between eyes (much longer than in *occitana*). Body stout;

legs stout, spurs curved; male appendages short, slightly divergent, no longer than height of last segment, the latter much higher than long.

Wings broad toward tip as in *A. fundata,* marked much as in *A. occitana;* with scattered patches of white veins, and small dark spots; the subcosta and radius are dotted as well as spotted, above the origin of the radial sector there is a deep black spot between radius and subcosta, no spots along cubitus, one at base of pale stigma, also in the hind wing, latter not marked except veins partly pale. Costal area with two series of cells almost to base, nine to ten cross-veins before radial sector in fore wings, five in hind wings, nine branches to radial sector, cubitals not connected, banksian lines distinct, second and third anals united for short distance, then the third forked and connected once back to the second.

In the hind wings there is a remarkable structure at the apex of wing; the appearance is that the radius is suddenly turned backward in a curve. This is due to a bending down of the surface, and to the several small cross-veins being in one line, and the veinlets forked at this place, so that beyond, there are twice as many veinlets as usual.

Fore wing 52 mm., hind wing 46 mm., fore wing at stigma 12 mm. broad.

From Baguio, Benquet, Philippines (Baker). Navas has evidently misspelled his locality, obviously intended for Mindoro.

ASCALAPHIDÆ

Suhpalacsa reducta sp. nov.

Face black, yellowish each side near the eyes; clypeus and labrum pale; face clothed with gray hair on lower part, dark above; vertex black, with dark hair; antennæ faintly annulate with pale on bases of joints; thorax above dull grayish black, with much dark and some pale hair; pleura gray, with long white hair; legs black, but rather paler on base, some long white hair on femora, spurs about equal to first tarsal joint; abdomen dull black, last

segments with black hair. Wings hyaline, the stigma black, nearly as long as broad; venation dark brown to black; hind wings much shorter than fore pair, and scarcely broadened on the basal part; apical field with two rows of cells; in fore wing four cross-veins before radial sector, in hind wing but two, and the radial sector arises about even with the fork of cubitus; in both pairs but four cross-veins before cubital fork; five branches of radial sector; the first anal does not run into cubital fork, but bends down to margin; in hind wings the cubital area has but two rows of cells, in the fore wing the cubital area has two to four rows of cells, irregular in arrangement.

Length of fore wing 29 to 32 mm., length of hind wing 23 to 25 mm.

From Philippines, Mt. Makeling, Luzon, Island of Samar, and Suerno Mts., Negros.

By its dark face, black legs, wholly dark thorax, two-celled apical field, and open venation, particularly but two cross-veins before radial sector in hind wing, it is separated from all described species.

Chrysopidæ

Chrysopa obliquata sp. nov.

Pale yellowish; face, vertex, and antennæ unmarked, but each side on vertex close to the eye is a narrow red stripe. Pronotum rather darker on sides than in middle, rest of thorax and legs pale; abdomen discolored. Wings hyaline, venation pale, gradates brown, ends of radial cross-veins and a few others partly dark, stigma whitish in both wings, elongate. In hind wing venation pale, but the ends of marginal forks on the outer hind margin are dark. Cubital cells slender, the second scarcely swollen above, divisory veinlet ends on the cross-vein above; gradate veinlets eight and nine, first series curved, nearer to radial sector than to the second series; in hind wings the rows more nearly parallel; in both wings there is a remarkable peculiarity in the outer radial cross-veins, those on basal part are straight across as usual but beyond middle they become

very oblique and sinuous, and consequently the radial sector does not bend up so near to the radius as in other species.

Length of fore wing 15 mm., width 5.5 mm.
From Bagio, Benguet, Philippines (Baker).

Spilosmylus ceylonensis Petersen

Petersen described the male; I have both sexes of what appears to be this species, and give the description of the female.

♀ Black; vertex with some red brown marks above; antennæ pale, basal joints dark; on pronotum and also mesonotum are small sharp tubercles or granules, each tipped with a hair; legs pale, front tibiæ with three dark dots above. Wings hyaline; venation pale, sometimes dotted with brown, and some cross-veins wholly brown or margined with brown, several of these spots near cubitus; stigma whitish, with dark at base; between subcosta and radius about six dark spots touching the veins, the last one paler, above these the costal cross-veins are brownish, and behind them there are faint brownish streaks across the wing; outer margin with some dark dots; at end of basal third on the hind margin is a brown tubercle or pupilla not one-half as long as in *S. tuberculatus,* and wholly dark. Hind wings with faint spots between subcosta and radius, the stigma, and some dots along outer margin brown. In fore wings there are two medio-cubital cross-veins before the median fork; between cubitus and its fork are fourteen to sixteen cross-veins; about fifteen cross-veins between radius and radial sector; radial sector with ten to twelve branches; first anal with six or seven branches to margin; in hind wings the base of median fork has the usual appendiculate veinlet.

Length of fore wing ♀ 17 to 19 mm., width 6.5 to 7.5 mm.
Length of fore wing ♂ 20 mm., width 7 mm.
Females from Kandy, Ceylon, May (E. E. Green).
Male from Ceylon (Nietner) Hagen Coll.

In both sexes the fork of the median is only a little before the first fork of the radial sector, not as far as Petersen figures; but I doubt that there are two species closely allied on Ceylon. The male has the pronotum striped and lines on subcosta and radius and between as Petersen describes.

SERICOSTOMATIDÆ

Goera tagalica sp. nov.

Fig. 2.

♀ Face with a crest of stiff hairs inward of each eye, yellowish at base, brown beyond; basal joint of antenna with yellow hair, but brown hairs near base below, rest of antenna brown, faintly annulate with pale; vertex with dense erect yellow hair; palpi black-haired; thorax with long, erect yellow hair in middle and in front; abdomen dull brown above, more yellowish beneath; front legs mostly dark, others yellowish, the femora more or less brownish, spurs black. Fore wings densely clothed with golden hair, outer fringe black or brown, some black hairs along the veins, bare spot conspicuous; hind wings dark, with nearly black hair and fringes.

Basal joint of antenna long, plainly longer than in *G. conclusa*. In fore wing the first fork goes fully one-half way back on the discal cell, forks two and three equal, the bare space at thyridium rather larger than in *G. conclusa*, about as in *G. octospina*. In hind wing fork one is only equal to fork three, very much shorter than fork two; fork five is but little wider and scarcely longer than fork three. The last ventral segment has a very short, blunt, median spine, and a tiny spine each side of it.

Expanse 17 mm.

From Mt. Makeling, Luzon (Baker).

Differs at once from the two species known from the Philippines by the short fork one of hind wings.

Goerinella minor sp. nov.

Fig. 6.

Palpi pale yellowish, last joint of maxillary palpi white; basal joint of antennæ nearly black; vertex and thorax with brown hair. Legs pale; abdomen brown above, yellowish below, male genitalia very large, lower appendages three jointed, the second joint very large, superior appendages long, slender, up-pointed at tip. Wings short and broad, venation similar to *G. piscina,* but the end of thyridial cell is farther out, plainly beyond base of the discal cell. Scales of fore wing golden to brown, on the costa dense and dark brown; hind wing fumose, costal area hairy, the posterior fringes very long.

Expanse 10 mm.

From Mt. Makeling, Luzon (Baker).

Anisocentropus bellus sp. nov.

Fig. 8

Head, palpi, and first and second joints of the antennæ yellow, with yellow hair, rest of antennæ black, the tips of joints marked with white; thorax yellow, with yellowish hair; abdomen dark brown above, yellowish below; femora yellowish, tibiæ and tarsi brownish, hind tibia and basitarsus with long brown hair. Basal half of fore wings pale brown, with yellowish hair, beyond clothed with black hair, with a curved band of bluish or lavender scales nearly across before tip, then along outer margin, and bending up to about the middle of the pale base; in the enclosed area is another patch of these lavender iridescent scales, with two fingers reaching toward tip of wing; the black marginal fringe is interrupted with tawny spots; hind wings brown, darker at tips. The front tibiæ and tarsi are faintly curved. The wings are more elongate than in

A. magnificus or *A. illustris*, and the venation is not very distinct, but appears much like those species.

Expanse 24 mm.

From Mt. Makeling, Luzon (Baker).

HYDROPSYCHIDÆ

Macronema caliptera sp. nov.

Fig. 9.

Head and palpi bright yellowish, about four basal joints of antennæ also, then several joints brown to black, then about three joints white, beyond brown, at first white annulate, but toward tip wholly brown. Thorax and pleura black, abdomen dark brown; front femora and tarsi pale, tibiæ brown, mid and hind femora dark, mid femur paler at tip, hind tibia dark brown, mid tibia pale, dark at tip, both tarsi pale on base, dark toward tip. Wings dark brown, much broken with pale, especially toward base, at apical third a nearly complete curved pale band, divided by hardly more than a line, a little before this is a pale band three-fourths way across, on hind margin a little before this is a small pale spot, basal part pale, longitudinally divided by a brown streak, and the hind margin dark, gradually fading within; on costal base is a yellow spot, followed by a black spot, which is extended obliquely into the pale; the two median dark bands have golden scales through their middle, not reaching hind border. Hind wings dark, tip almost black, just before tip on costal margin is a pale spot. The venation is similar to that of *M. radiatum* and *M. opulentum* with the median cell broad and truncate at base.

Expanse 20 mm.

From Mt. Makeling, Luzon (Baker).

Dipseudopsis spectabilis sp. nov.

Fig. 1.

Head black, on vertex behind and near eyes yellowish; basal joint of antennæ yellowish, beyond black; palpi black; pronotum and rest of thorax black; abdomen black above, pale beneath; legs and spurs pale, coxæ dark. Fore wings dark brown with several large pale areas, mostly yellowish, but one beyond anastomosis more hyaline; an oblique spot from basal hind margin and an elongate spot in front of it, a large spot on hind margin, mostly before arculus, and reaching up to medius, a smaller triangular spot above base of discal cell, an elongate spot in discal cell, and one in the cell behind it; behind the anastomosis two elongate streaks, one in area behind fork two, and other over most of fork four and some in cell behind, these streaks broadly connected at base, and neither reaching the margin. Hind wings pale brown; fork one in fore wing very short, fork three with a pedicel nearly one-half of its length; in hind wing fork two reaches back in a point to the discal cell; and the cross-vein from basal part of median cell reaches extreme base of fork five. The inner spur of hind tibia ends in three points, the outer one much the longer and stouter, the middle one quite short.

Expanse 22 mm.

From Sandakan, Borneo, C. F. Baker.

RHYACOPHILIDÆ

Rhyacophila carletoni sp. nov.

Fig. 7.

Yellowish; head and thorax with mostly pale yellowish hair; antennæ pale, scarcely annulate with dark; palpi rather long and very slender. Legs pale, the tibiæ and part of tarsi darker, spurs pale; abdomen dark above, pale beneath. Fore wings pale, with many brown spots, mostly

small and scattered, a large one over base, a prominent oblique one over middle of anal area, another, smaller, above the end of anal vein, several more or less connected spots near stigma, outer margin alternately brown and pale; hind wings scarcely infumate. In fore wings fork one barely longer than two, fork three long, about four times as long as pedicel, the connecting veinlet out on fork two, fork four as far back as fork two, and fork five fully as far back as base of discal cell. In hind wings forks one and two equal, fork three fully four times as long as its pedicel.

Expanse 30 mm.

From Kooloo, North India (Carleton coll.).

Explanation of Plate 5.

Fig. 1. *Dipseudopsis spectabilis,* fore wing.

Fig. 2. *Goera tagalica,* tip of abdomen, and spines of last ventral segment.

Fig. 3. *Ectopsocus æthiops bakeri,* fore wing.

Fig. 4. *Eophanes formosa,* prothorax and head.

Fig. 5. *Madrasta handlirschi,* venation at apex of hind wing.

Fig. 6. *Goerinella minor,* genitalia side, and lower appendage from below.

Fig. 7. *Rhyacophila carletoni,* genitalia side.

Fig. 8. *Anisocentropus bellus,* fore wing.

Fig. 9. *Macronema caliptera,* fore wing.

PROCEEDINGS OF THE CAMBRIDGE ENTOMOLOGICAL CLUB

Ten meetings were held in 1930, including one special meeting in September. The programs were as follows: Jan. 14, Dr. F. M. Carpenter, "A Review of our Present Knowledge of the Geological History of the Insects." Feb. 11, Mr. P. J. Darlington, Jr., "Notes on Northern Colombia and its Insects." March 11, Dr. J. Bequaert, "Some Notes on the Entomology of Yucatan"; Mr. W. S. Creighton, "Remarks on the Ant Genus Myrmoteras." April 8, Mr. W. J. Clench, "Notes on the Insect Fauna of Navassa"; Mr. J. H. Emerton, "Notes on Spiders." May 13, Dr. M. Hertig, "The Phlebotomus Sand-flies, Their Medical Importance." June 10, Mr. G. S. Tulloch, "Mosquito Control in Massachusetts." Sept. 9, Summer Collecting Notes. Oct. 14, Dr. J. Bequaert, "The Characters and Distribution of the North American Hornets and Related Wasps." Nov. 11, Mr. D. L. Collins, "Phototropic Reactions of Certain Moths"; Dr. F. M. Carpenter, "Notes on a New Genus of Mecoptera." Dec. 9, Prof. N. Banks and Dr. F. M. Carpenter, "An Entomological Trip to the Carolina Mountains."

During 1930, the club lost four members by death. Two of the deceased, Mr. George Dimmock and Mr. J. H. Emerton, were charter members of the club. Five new members were elected, bringing the total membership to 92.

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CAMBRIDGE ENTOMOLOGICAL CLUB

A regular meeting of the Club is held on the second Tuesday of each month (July, August and September excepted) at 7.45 p. m. in Room J, basement of the Peabody Museum, Divinity Ave., Cambridge. Entomologists visiting Boston are cordially invited to attend.

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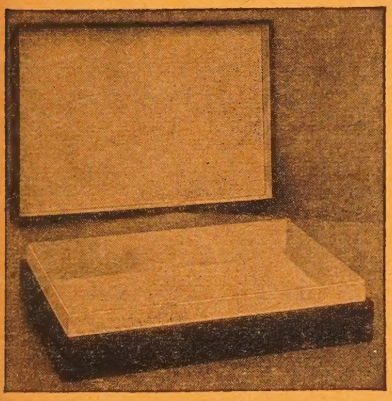

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